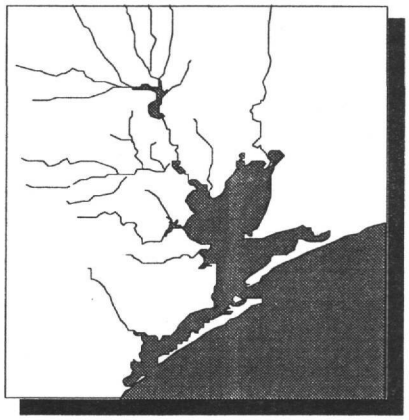


IV.
Water and Sediment Quality Improvement

This section of *The Galveston Bay Plan* deals with the relationship between water/sediment quality and pollutant loadings to the bay. Three action plans have been developed to address general water/sediment quality issues and problems with point source and non-point source pollutant loadings.

Water and Sediment Quality Two major water and sediment quality problems have been identified: certain toxic substances have contaminated water and sediment, and dissolved oxygen is reduced in certain tributaries and side bays, harming marine life. To address these concerns, actions plans were developed to determine the sources of ambient toxicity, set sediment quality standards, perform loading studies for toxics and oxygen-demanding pollutants, and to support the Clean Texas 2000 Pollution Prevention Program **(see page 163)**.

Non-Point Sources of Pollution Urban runoff has been ranked as the second-most important priority problem to the bay. A series of actions, many coordinating and strengthening existing and proposed programs, have been developed for *The Galveston Bay Plan*. A total of 15 different actions target non-point sources of pollution from existing urban development, new urban development, roadways, agriculture, industry, and marinas **(see page 179)**.

Point Sources of Pollution While there has been a dramatic reduction in point source loadings since the 1960s, there are still some areas of concern. Many municipal systems still have bypass, overflow problems, and connection problems, allowing raw or partially treated sewage to enter Galveston Bay. The City of Houston is currently undertaking a $1.2 billion program to correct some of these problems, and other municipalities may need to implement similar programs. A second major problem is that produced water discharges from oil production platforms have a negative effect on aquatic life in the tidal zone. *The Galveston Bay Plan* includes an action to eliminate harm from these discharges **(see page 199).**

Water and Sediment Quality

The Galveston Bay Plan
Galveston Bay National Estuary Program

OVERVIEW OF THE ACTIONS

THE ISSUES

The Galveston Bay system is characterized as having relatively good water quality in open bay segments. Water quality problems, where they occur, are found in the western, urbanized tributaries. In general, the water quality problems in these locations have shown tremendous improvement over the past 20 years because of improved wastewater treatment. Although data in many cases is limited, localized problems remain. Isolated, localized areas of sediment toxicity exist, and certain Houston Ship Channel segments exceed water quality criteria for some selected contaminants such as PCBs, DDT, and heavy metals. Biomagnification and accumulation of toxicants occurs in tissues of certain estuarine organisms, and increases the potential risk associated with consuming contaminated seafood from local problem areas within the Galveston Bay Estuary. Although there has been dramatic improvement over the past 20 years, the upper Houston Ship Channel still has a problem with low dissolved oxygen (DO) concentrations compared to most other parts of the bay, impairing the full utilization of the channel by aquatic life. High levels of bacteria in open bay waters has closed over half of the bay to oystering, and some tributaries exceed the standards for safe contact recreation.

An action plan has been developed to improve the water and sediment quality in certain areas of the bay. This goal will be achieved by reducing the toxicity and contaminant concentrations

in the water and sediments and increasing the dissolved oxygen concentration in certain tributaries and side bays. These efforts should lend support to a healthy ecosystem and minimize risk to human health.

- Contaminant Reduction: Five actions are presented to address the elimination of ambient toxicity in Galveston Bay water and sediments. Several types of surveys are advocated to identify the sources of contaminants and toxicity found in the water and sediment. Efforts made by the Texas Natural Resource Conservation Commission (TNRCC) to establish and adopt sediment quality criteria are supported as well as the TNRCC Clean Texas 2000 Pollution Prevention Program.

- Dissolved Oxygen Augmentation: Two actions are promoted by *The Galveston Bay Plan* to address the lack of sufficient dissolved oxygen in certain areas of the bay. An increase in the dissolved oxygen concentration may promote aquatic life in areas of the bay system that have been historically unproductive. Studies to determine relative contributions of nutrients, oxygen-demanding materials, and hydrodynamic factors will aid in identifying problem areas and establishing biological oxygen demand (BOD) loading rates.

ENVIRONMENTAL STATUS

GBNEP Ambient Water and Sediment Quality Study

The authors of a GBNEP study that evaluated the existing monitoring data for the bay concluded that the water and sediment quality of the Galveston Bay system is "generally good, and where it is degraded it is showing a pattern of improvement." This conclusion was based on a detailed analysis of available water and sediment quality databases extending from 1965 to the present for most parameters. The task involved compiling a massive database from numerous separate sources, creating the most extensive and detailed long-term record of water and sediment quality ever assembled for the estuary. The study took an *ambient* or "in-the-bay" approach to complement other studies of potential pollution *sources* like point and non-point source pollution. The authors' conclusions regarding key water and sediment quality indicators are provided below.

Temperature

Water temperature has declined approximately 1° over 20 years, with the most prevalent decline occurring in the summer months. Since 1985, there have been violations of the 95°F (35°C) standard in two segments, both in the Houston Ship Channel. The frequency of violation is on the order of 5 percent for the two segments.

Salinity

Substantial gradients across the bay are a normal feature of salinity structure, declining on the average from values of about 30 parts per thousand (ppt) at the inlets to the Gulf to about three ppt near principal points of inflow, such as the Trinity River. Although many human activities (such as impoundment of rivers and sea water intrusion through dredged channels) were

thought to threaten the bay with a salinity increase, a four parts per thousand (ppt)*decline* in salinity has been observed in Galveston Bay over the past three decades. Salinity decreases are prominent in the lower bay (especially East Bay), and in areas influenced by intrusion from the Gulf of Mexico, particularly west of the Houston Ship Channel. Seasonally, the decline has been especially noticeable in late summer. An unexpected lack of direct linkage between freshwater inflow and bay salinity suggests the dynamics of Gulf interchange, return flows, and localized runoff may be much more important (and more complex) than previously suspected.

Geographically, the low salinities of the river-influenced upper bay normally grade to high salinities in the Gulf-dominated lower bay. Variability was shown to be high, however, with a standard deviation of 5-6 ppt throughout the bay. Salinities in the open bay reach of the Houston Ship Channel were some 2 ppt higher than those of adjacent waters. Variability with depth (stratification) was slight by estuarine standards, generally averaging less than 0.6 parts per thousand per meter (ppt/m) of which about half the bay area was less than 0.3 ppt/m, and showing no geographic correlation with total water depth. This was an expected condition in this shallow, wind-driven estuary.

Suspended Solids and Turbidity

Suspended solids, and the related parameter turbidity (cloudiness of the water), are associated with river inflows and dredging activities. Surprisingly, the GBNEP ambient water quality study indicated that there has been an approximate 50 percent decline in suspended solids and turbidity over the past 20 years. This has resulted in much clearer water in most portions of the bay compared to conditions in the early 1970s.

Dissolved Oxygen.

The oxygen dissolved in water (DO) is critically important to living organisms and to the overall health of the bay ecosystem. DO levels in the bay are generally determined by photosynthesis and wind action (which increase DO) and oxygen-demanding pollutants and plant and animal respiration (which reduce DO). DO is generally high throughout Galveston Bay, averaging near-saturation in large areas of the bay, with frequent occurrences of concentrations greater than the equilibrium concentration with air (supersaturation). Exceptions to this are in poorly flushed tributaries subjected to inflow and waste discharges, most significant of which is the Houston Ship Channel.

Traditionally, low DO has occurred in poorly flushed areas that receive nutrients and oxygen-demanding material from wastewater and runoff—that is, in the urbanized tributaries and the upper Houston Ship Channel. Twenty years ago, there was essentially no oxygen in the upper Houston Ship Channel, and therefore no fish. Critically low DO has not traditionally been a problem in open well-aerated portions of the bay, and this study confirms DO levels near (or even above) the saturation point in these areas, with little depth stratification.

Segment Number	Segment Name	Designated Uses [1]								Standards [1]	
		cr	hqh	sfw	iws	ncr	iqh	pdws	nav	DO	FC
2421	Upper Galveston Bay	•	•	•						4.0	14
2422	Trinity Bay	•	•	•						4.0	14
2423	East Bay	•	•	•						4.0	14
2424	West Bay	•	•	•						4.0	14
2425	Clear Lake	•	•							4.0	200
2426	Tabbs Bay	•	•							4.0	200
2427	San Jacinto Bay	•	•							4.0	200
2428	Black Duck Bay	•	•							4.0	200
2429	Scott Bay	•	•							4.0	200
2430	Burnett Bay	•	•							4.0	200
2431	Moses Lake	•	•							4.0	200
2432	Chocolate Bay	•	•	•						4.0	14
2433	Bastrop Bay/Oyster Lake	•	•	•						4.0	14
2434	Christmas Bay	•	•	•						4.0	14
2435	Drum Bay	•	•	•						4.0	14
2436	Barbours Cut	•	•							4.0	200
2437	Texas City Ship Channel		•			•				4.0	200
2438	Bayport Channel		•			•				4.0	200
2439	Lower Galveston Bay	•	•	•						4.0	14
Trinity River											
0801	Trinity River Tidal	•	•							4.0	200
0802	Trinity R. below L. Liv	•	•					•		5.0	200
Trinity–San Jacinto Coastal											
0901	Cedar Bayou Tidal	•	•							4.0	200
0902	Cedar Bayou Above Tidal	•	•					•		5.0	200
San Jacinto River											
1001	San Jacinto River Tidal	•	•							4.0	200
1005	HSC/San Jacinto River		•			•				4.0	200
1006	Houston Ship Channel				•				•	2.0	2000
1007	HSC/Buffalo Bayou				•					1.0	2000
1013	Buffalo Bayou Tidal	•					•			3.0	200
1014	Buffalo Bayou Above Tidal	•					•			—	—
San Jacinto-Brazos Coastal											
1101[2]	Clear Creek Tidal	•	•							4.0	200
1102[2]	Clear Creek Above Tidal	•	•							5.0	200
1103	Dickinson Bayou Tidal	•	•							4.0	200
1104	Dickinson Above Tidal	•	•					•		4.0	200
1105	Bastrop Bayou Tidal	•	•							4.0	200
1107	Chocolate Bayou Tidal	•	•							4.0	200
1108	Chocolate Above Tidal	•	•							5.0	200
1113	Armand Bayou Tidal	•	•							4.0	200

Note: 1: *cr = contact recreation, hqh = high quality habitat sfw = shellfish waters*
iws = industrial water supply ncr = non contact recreation iqh = intermediate quality habitat
pdws = public domestic water supply nav = navigation
DO = dissolved oxygen, mg/L FC = fecal coliform, colonies/100 mL

Note 2: *Segments 1101, 1113, and 2422 are subdivided, constituting a total of seven segments. HSC: Houston Ship Channel*

FIGURE WSQ-2. Present Texas Natural Resource Conservation Commission Water Quality Segments, Designated Uses, and Standards in the Galveston Bay System

Within the upper Houston Ship Channel above the San Jacinto confluence, DO has *increased* by about 4 parts per million (ppm) in the past 20 years. (Other studies confirm that substantial numbers and kinds of fish and other organisms have returned to this area). However the level of oxygen demanding materials present measured as biological oxygen demand, (BOD) remains higher in the upper Ship Channel, in the upper Bay along the north and west shores, and in Clear Lake.

Nutrients

Prior to studies performed by the Galveston Bay National Estuary Program, there was a general concern that nutrients originating from agricultural runoff, urban runoff, and wastewater point sources were over-enriching Galveston Bay, leading to eutrophication. In many east coast estuaries, this produces widespread algae blooms from the fertilizing effect, loss of dissolved oxygen, and fish kills. But the overall view revealed by the GBNEP study (for the first time) shows a different picture. Phosphates, ammonia, and nitrates all show a substantial general *decline* bay-wide, with some localized exceptions (the urban bayous and Ship Channel remain problem areas).

The analysis also revealed an unexpected glimpse into possible effects of nutrient declines on bay productivity—the food chain process that begins with green plants like phytoplankton and ends with predators like game fish and human consumers. Although cause and effect are not yet linked, the bay apparently grows less algae and has clearer water than it did 20 years ago. A general decline in Chlorophyll *a* (a measure of phytoplankton) and a halving of total suspended solids (including both algae and inorganic particles) was noted over the last two decades. Suspended solids in the Trinity River have also declined by a factor of three since the closure of Lake Livingston in 1970, and suspended solids from waste discharges have declined by an estimated factor of 10. Reduced total organic carbon and turbidity in the bay reinforce this pattern.

A decline in primary productivity that is provided by phytoplankton could have serious food web implications. The root meaning of "eutrophication" is simply "the process of becoming well fed." What is a well-fed estuary, and when is it under- or over-fed? At what point does primary productivity reduction in phytoplankton affect higher levels in the food chain, and hence the bay's economy? Questions raised by the project will await further work.

What we do know is the relative contributions of nutrients from a variety of sources, such as industrial point sources, municipal point sources, urban runoff, agricultural runoff, and the upper watershed:

Source	Percentage of Annual Loading to Bay (%)	
	Total Nitrogen	Total Phosphorus
Industrial Point Sources	7 %	4 %
Municipal Point Sources	37 %	30 %
Local Urban Runoff	3 %	33 %
Local Agricultural Runoff	1 %	13 %

continued

Source	Percentage of Annual Loading to Bay (%)	
	Total Nitrogen	Total Phosphorus
Other Local Runoff	1 %	7 %
Upper Watersheds	51 %	13 %

As can be seen from these figures, municipal point sources and the upper watersheds are the largest contributors of nutrients to the bay. Agriculture is a surprisingly low source of nutrients, primarily because much of the agricultural lands are rice fields that lose relatively little nutrients during rain events.

Bacteria

Open-water portions of Galveston Bay generally conform to Texas water quality criteria for contact recreation. Areas where the long-term fecal coliform bacteria levels exceeded the state standards for contact recreation are in western, developed tributaries of the bay: Buffalo Bayou, White Oak Bayou, Clear Creek, Dickinson Bayou, and Chocolate Bayou. In some of these areas, contact recreation is common and unregulated. Bacteria data show no increasing trend that could be associated with human activities in the watershed.

While many regulatory changes have taken place over the years in shellfish harvesting regulation, the area of the bay subject to shellfish closure has remained about the same for four decades. Wet weather runoff appears to be the most significant source of bacteria, but concentrations in the open bay tend to be localized and of short duration. For example, many of the conditionally approved areas for oyster harvesting are reopened within a few days after heavy rain events. Many of the shellfish closures result from either a small portion of the data exceeding higher values, generally after rains, or a judgment made about the potential for upland facilities to introduce pathogens.

Toxics

Contaminants such as metals and trace organics (pesticides, PCBs) showed elevated levels in regions of runoff and waste discharge, with generally the highest values in the upper Ship Channel, and generally low values in the open bay waters. Using total metals data that will overestimate dissolved metals concentrations, the existing data show *potential* criteria violations for dissolved heavy metals along the Houston Ship Channel (both open-bay and landlocked reaches), along the Intracoastal Waterway, and in turning basins. Declines were noted for most of the toxic metals, both in water and sediment, in areas of maximal concentrations. This is especially true for the Upper Houston Ship Channel, where the rates of decline per decade for sediment concentrations of chromium, mercury and zinc are a factor of two; for copper and nickel a factor of three; and for arsenic, cadmium and lead a factor of ten. Although historical metals measurements may overestimate actual concentrations, metals in water appear to be at or below levels that would be satisfactory for an estuary (sediment standards do not yet exist). Isolated areas of elevated concentrations probably exist near specific sources of metals.

Most measurements of trace organics such as pesticides were below detection limits, precluding statistically reliable information on trends. Two out of 18 measurements in two

Houston Ship Channel segments exceeded the EPA's criterion for chronic DDT concentration. In three of the Ship Channel segments the EPA's PCB criteria for marine and freshwater environments were violated in 8 out of 16 measurements. Both these compounds are now highly regulated, but their high persistence is evident in the data.

Several monitoring programs have also focused on the accumulation of toxics in seafood and the associated health risks of these chemicals. Accumulation of PCBs and PAHs (polynuclear aromatic hydrocarbons, combustion byproducts and constituents of oil and creosote) in fish, oysters, and crabs has increased the risk of consuming seafood from Galveston Bay. Two seafood advisories caused by concern over toxics currently exist for the Galveston Bay system: the first is based upon dioxin contamination in a limited area of the upper bay, and the second is based on three industrial solvents found in fish from Clear Creek. See the Public Health Protection Action Plan for more information about these seafood studies.

Sediments

In Galveston Bay, commonly measured organic compounds and metals appear to follow the same general spatial distribution as most of the water quality parameters: elevated concentrations in regions of runoff, inflow and waste discharges, and lower, more-or-less uniform concentrations in the open bay, with the Houston Ship Channel generally the focus of maximal concentrations in the system. Where trends in metals are discernible, they tend to be declining, especially in the upper Houston Ship Channel. Over the past decade, these rates of decline have been sufficient to reduce sediment concentrations of chromium, mercury and zinc by a factor of two; copper and nickel by a factor of three; and arsenic, cadmium and lead by a factor of ten.

Other Studies

The Texas Water Commission compiled an annual overall ranking for 104 water quality segments in Texas which included 31 of the segments in and around Galveston Bay. The Houston Ship Channel had the lowest ranking (worst water quality) with identified problems in the area of toxics, known non-point sources, high point sources, fish kills, low dissolved oxygen, fecal coliforms, and nutrients. Upper Galveston Bay was ranked as 34th lowest out of the 104 segments and Trinity Bay was ranked 69th. East Bay, West Bay, and Chocolate Bay had high rankings (94th, 96th, and 102nd, respectively), indicating relatively good water quality in these areas. The Texas Department of Health (TDH), using data collected by the U.S. Environmental Protection Agency (EPA), has also issued advisories regarding dioxin pollution in certain upper portions of the Houston Ship Channel and Galveston Bay.

There is still considerable uncertainty in the Galveston Bay system about deposition of pollutants from the atmosphere. In other estuary systems, air deposition is a significant source of some parameters, such as nitrogen in Chesapeake Bay. A rough estimate, prepared for the Galveston Bay State of the Bay Report, indicates that air deposition may be responsible for around 12 percent of the annual nitrate/nitrite load, one percent of the annual lead loading, and nine percent of the annual cadmium loading. Note these estimates were developed using general deposition rates from other parts of the country. Additional work needs to be performed to make more accurate, site-specific loading estimates for Galveston Bay.

Probable Causes

General

Potential causes for the observed changes in water quality described previously were presented in the GBNEP ambient water and sediment quality report, and are summarized below:

Change in Parameter	Possible Causes of Change
Declining Temperature	Long-term changes in climatology Long-term changes in water temperature in Gulf Alterations in the intensity of interaction with Gulf
Declining Salinity	Decreased salinity in adjacent Gulf of Mexico Increased inflow from local watersheds Decreased interaction with Gulf
Increasing Dissolved Oxygen in Houston Ship Channel	20-fold reduction in industrial and municipal oxygen-demand loadings since 1970
Decreasing Suspended Solids and Turbidity	Reduced loadings from the main river system, probably due to reservoir construction and changes in upper watershed Reduced loadings from the local watershed Reduced loadings from treatment plants
Decreasing nutrients	Reduced loadings from the main river system, probably due to reservoir construction and changes in upper watershed Reduced loadings from treatment plants
Decreasing chlorophyll	Decreased nutrient supply Increased toxicity to phytoplankton Increased phytoplankton predation Altered species distribution

Problem areas in Galveston Bay for pollution of water and sediment are in areas of intense human activity, including urban areas, points of surface runoff, waste discharges, and shipping.

Toxics

The observed decline in concentrations of metals in the waters and sediments of the Galveston Bay system is probably related to improved wastewater treatment from industrial and municipal sources. Two compounds which have been shown to cause problems, DDT and PCBs, are now no longer manufactured and their use is highly regulated. These compounds are highly persistent in the environment, however, and are still found in the Galveston Bay system. Most of the PAHs that contribute to health risks in seafood are associated with combustion byproducts and not with releases of crude oil or creosote compounds, although some non-combustion PAHs contaminate sediments in localized areas around produced water discharges. Sources of the low levels of dioxin found in the upper bay are typically associated

with paper and pulp manufacturing, and three industrial chemicals found in fish from Clear Creek are also found at the former Brio Refining Company, a EPA Superfund site where a cleanup of toxic industrial compounds is now underway.

Oxygen Demand

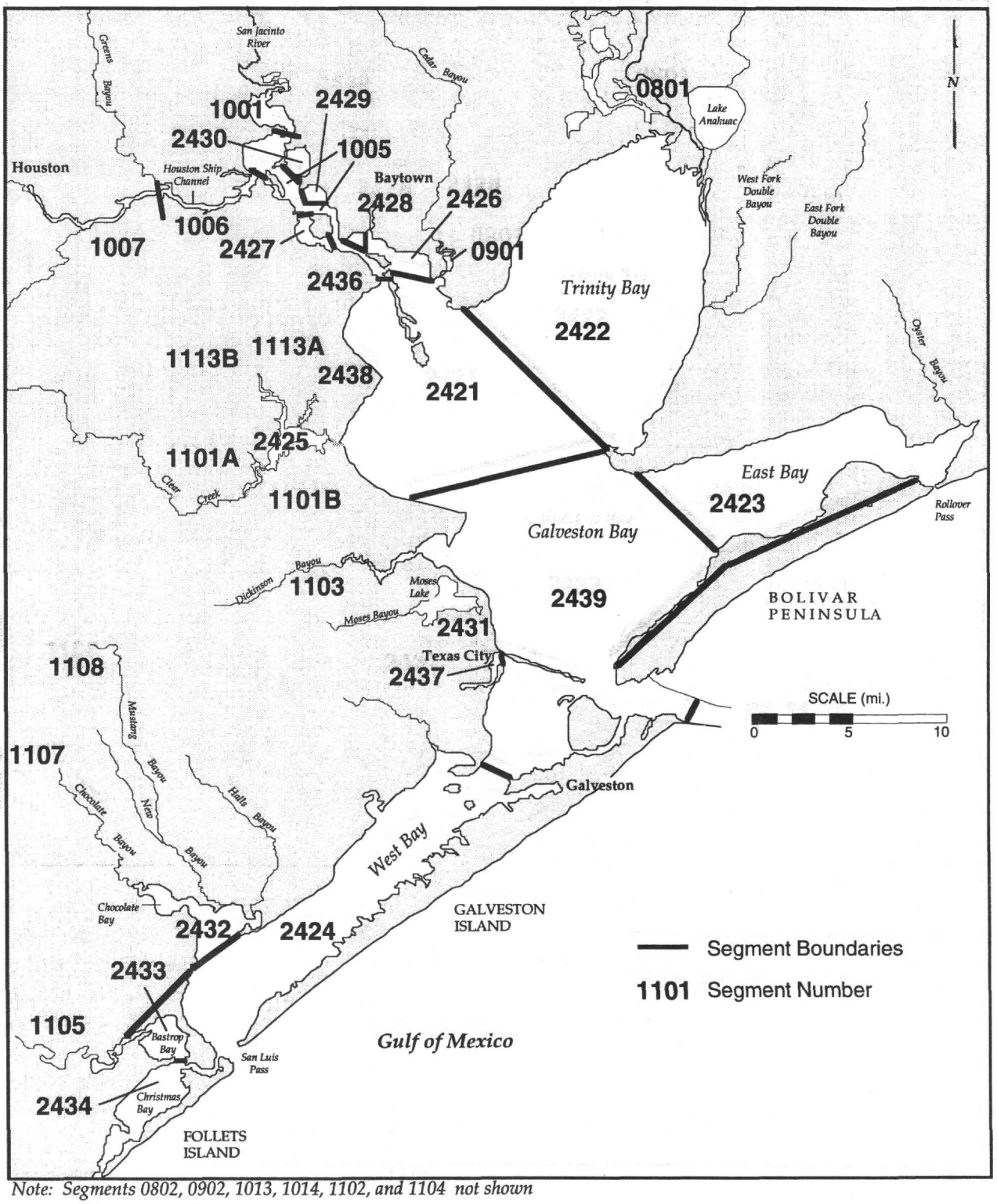
In most Galveston Bay waters, scattered violations of the dissolved oxygen standards (generally about two percent of the data show violations) indicate no serious or systematic water quality problems. Estuarine segments with some reported dissolved oxygen problems include Buffalo Bayou Tidal, Clear Creek Tidal, and Armand Bayou Tidal. Compared to the upper Houston Ship Channel, the other dissolved oxygen problems appear to be limited in scope and severity.

An evaluation of different oxygen demanding substances (Biochemical Oxygen Demand or BOD) indicates that most of the BOD loading to the bay originates from non-point sources in the local watershed (downstream of Lake Livingston and Lake Houston). On an annual basis, the overall BOD loading is distributed between these sources:

Source	% Contribution to Annual BOD Loading to Bay
Municipal Point Source	3 %
Industrial Point Sources	7 %
San Jacinto River	7 %
Trinity River	27 %
Local Urban Non-Point Sources	31 %
Local Agricultural Non-Point Sources	6 %
Local Forested and Open Non-Point Sources	14 %
Local Other Non-Point Sources	5 %

Note that the urban land uses reflect an incremental increase in non-point source loadings over pre-development conditions such as open pasture or forest. In other words, the average post development BOD loading from urban areas is about 30 kg of BOD per year per acre of land, compared to about 6 kg BOD per year per acre for forest or open land uses. Therefore even if all of BOD loads from urban development were reduced to pre-development conditions, the urban areas would still contribute about five percent of the total annual BOD load to the bay compared to the estimated amount of 31 percent shown above.

In the Houston Ship Channel above Morgans Point, however, there has been a historical problem with dissolved oxygen concentrations. In the 1960s and 1970s, excessive point source discharges eliminated dissolved oxygen in the upper Ship Channel, virtually wiping out all aquatic life. Since 1968, however, there has been a 95 percent reduction in municipal and industrial point source BOD loadings, and the upper Ship Channel now has enough dissolved oxygen to support an "extensive" utilization of the Channel by numerous aquatic species.



Note: Segments 0802, 0902, 1013, 1014, 1102, and 1104 not shown

FIGURE WSQ-1. TNRCC Water Quality Segments for Galveston Bay and the Houston Ship Channel

Despite the dramatic reduction in municipal and industrial pollution between 1968 and 1990, there are still some low dissolved oxygen concentrations and exceedances of standards in the upper Houston Ship Channel. In Segment 1006 (San Jacinto River to Greens Bayou) the frequency of exceedance of the 2.0 milligram per liter dissolved oxygen standard has ranged between one and 12 percent after 1985. In Segment 1007 (Greens Bayou to I-59, including the Turning Basin) the frequency of exceedance of the 1.0 milligram per liter dissolved oxygen standard has ranged between one and six percent after 1985. Note that these stream segments have not been designated by the state to maintain aquatic life, and therefore the dissolved oxygen standards have been set lower than any other Galveston Bay segments (most of which have a 4.0 or 5.0 milligram per liter standard).

An estimate of the sources of carbonaceous oxygen demand loadings to the Houston Ship Channel was performed during a 1986 TWC study. The sampling data from this study indicated that industrial point sources were responsible for about 7 percent of the annual carbonaceous oxygen demand, municipal discharges 10 percent, municipal bypasses and overflows 11 percent, and non-point sources 72 percent. Since this time a large collection system improvement project has been implemented by the City of Houston resulting in elimination of dry weather overflows and a large reduction in wet weather overflows (see Point Sources Action Plan).

The low-dissolved oxygen problems in the Galveston Bay system are caused by a combination of 1) low flushing rates, 2) oxygen demand from point, non-point, and benthic sources, and 3) possible oxygen demand from excessive algal growth. No detailed studies have been performed at any of the areas with low-dissolved oxygen areas to determine the relative contribution of these different sources, although further reductions in point source loadings alone will probably not result in greatly improved dissolved oxygen in the Houston Ship Channel.

MANAGEMENT STATUS

Section 303 of the Clean Water Act (CWA) and Title 40, Part 131 of the Code of Federal Regulations require states to establish surface water quality standards subject to EPA approval. The state standards must contain: 1) designated beneficial uses for which a water body is to be protected, (such as drinking water, contact recreation, etc.); 2) criteria necessary to protect these uses; and, 3) an antidegradation policy. The state standards may meet or be more stringent than EPA requirements. The standards must be reviewed by the states every three years. In the spring of 1991, the Texas Natural Resource Conservation Commission (TNRCC) completed a "triennial" review of the Texas surface water quality standards. TNRCC is currently scheduled to complete another triennial review in 1994.

Designated water body uses include water recreation, water supply, industrial and agricultural use, and support of fish and aquatic life. Water quality standards also establish water quality-based treatment controls and strategies. Water quality standards are composed of the following elements:

- Use designations for each water body
- Methods used and analyses conducted to support revisions to the standards
- Water quality criteria for the protection and maintenance of each designated use
- An anti-degradation policy to protect water quality
- An implementation and enforcement plan

The TNRCC has been delegated the responsibility for developing water quality standards for the state. The surface water quality standards promulgated in 30 Texas Administrative Code (TAC) Chapter 307 include regulations for general water quality criteria and site-specific uses and criteria. General criteria are applicable to all surface waters in the state and are particularly important for managing pollutants not addressed by specific numerical criteria. General criteria are composed of the following elements:

- Aesthetic parameters (e.g., taste, odor, floating debris, etc.)
- Radiological parameters
- Toxic parameters (e.g., PCBs, pesticides, metals, etc.)
- Nutrient parameters
- Temperature
- Salinity
- Dissolved oxygen

Major surface waters of the state are classified as segments for water quality management purposes and the designation of site-specific standards. Site-specific uses for classified segments include

- Recreation (contact and non-contact)
- Domestic water supply (public water supply and aquifer protection)
- Aquatic life (limited, intermediate, high and exceptional quality of aquatic habitat and oyster waters)
- Navigation
- Agricultural water supply
- Industrial water supply

Segment-specific standards also list upper and lower limits for common water quality criteria such as dissolved oxygen, temperature, pH, dissolved minerals, and fecal coliform bacteria.

The state standards are subject to review and approval by the EPA and must be updated every three years. New information on potential pollutants, additional data on water quality conditions in specific water bodies, and new state and federal regulatory requirements must be incorporated into the revised standards. Standards that are currently in effect were revised by the TNRCC in 1990/1991 and approved by the EPA on September 24, 1991.

TNRCC's antidegradation policy has been developed to prevent increases in pollutant loadings to state surface waters. Provisions of the policy include:

- Maintenance and protection of existing water quality
- Prohibited degradation of waters which exceed fishable/swimmable quality
- Protection of outstanding natural resource waters
- Compliance with federal and state water quality standards for any waste discharges
- Compliance with applicable wastewater treatment provisions and best management practices
- Establishment of modified thermal discharge limitations consistent with the CWA

The policy is applicable to permit actions, waste load evaluations and any other actions related to non-point sources of pollution which may impact the waters of the state.

It has been proposed that Christmas Bay be designated as an outstanding natural resource water body. Provisions for this designation would include prohibition of permitted discharges directly into the bay; prohibition of new channel construction within the bay; and, allowance for maintenance dredging for existing channels only.

In accordance with the provisions of Section 106 of the CWA and Section 26.023 of the Texas Water Code, the TNRCC must establish appropriate monitoring methods and procedures to compile and analyze data on the quality of waters within the states. The monitoring program must include the collection and analysis of physical, chemical and biological data and the development of a quality assurance and control program to validate the information. The collected data are to be used to:

- Establish baseline water quality
- Predict pollutant impacts
- Develop and review water quality standards
- Determine allowable pollutant loads
- Assess NPDES compliance by dischargers
- Report information to the public
- Review site-specific monitoring efforts to determine if standards are being maintained or are appropriate for the segment

The Clean Water Act also provided for the establishment of nationally acceptable technology-based effluent limitations to be promulgated by type of industry. The mechanism for implementing effluent limitations for point source discharges into surface waters is the National Pollutant Discharge Elimination System (NPDES) permit. These permits are issued by the EPA or a delegated state in accordance with the provisions of Section 402 of the CWA. Texas has not been granted this delegation and facilities in Texas must obtain a permit from both the TNRCC and the EPA.

Section 402 of the CWA added storm water runoff as a waste stream subject to NPDES permit requirements. Regulations promulgated by the EPA in 1990 established group and individual permit application requirements for storm water discharges associated with industrial activities and municipal separate storm sewer systems. Discharges of storm water from these sources must comply with water quality standards.

WATER AND SEDIMENT QUALITY ACTION PLAN

To maintain and improve the water and sediment quality of Galveston Bay in order to support a healthy ecosystem and minimize risk to human health.

OVERVIEW

Priority Problem

A few specific toxic substances have contaminated water and sediment in isolated, localized areas and may have a negative effect on aquatic life in contaminated areas. For example, a limited number of samples (less than 20) indicates that there have been exceedances in water quality criteria for PCBs (polychlorinated biphenyls, a banned chemical used mostly as a transformer oil) and DDT (also now banned) in the Houston Ship Channel/San Jacinto River segments. The GBNEP Ambient Water and Sediment Quality Study concluded that there have been some exceedances of criteria for arsenic, cadmium, chromium, and nickel, and that concentrations of these contaminants are at "the threshold of what would be satisfactory for an estuarine regime." (Note that in many cases the analytical results may have resulted in an overestimate of actual concentrations of metals in the water). In addition, the GBNEP toxicity study indicated some localized areas have water and sediment that exhibit some toxicity. The TDH, using data collected by the EPA, has also issued advisories regarding dioxin pollution in certain upper portions of the Houston Ship Channel and Galveston Bay. The EPA has included the Houston Ship Channel in a "short list" of waters exceeding priority pollutants criteria due to high concentrations of nickel. Finally, accumulation of PCBs and PAHs (polynuclear aromatic hydrocarbons, combustion byproducts and constituents of oil and creosote) in fish, oysters, and crabs has increased the risk of consuming seafood from Galveston Bay.

Goal

Reduce toxicity and contaminant concentrations in water and sediments. To accomplish this goal, additional studies are needed to determine current sources of these contaminants. PCBs and DDT production have been banned, for example, and additional studies are required to determine 1) if there are any continuing sources, and 2) how long it might take natural processes to eliminate these contaminants from the system. There have been some questions regarding the accuracy of heavy metals data from the bay, and more work is needed to determine if a serious metals problems does exist. In summary, the goal is to learn more about toxic materials in Galveston Bay, and then set appropriate standards (no standards are in place now) and acceptable loading rates from problem sources.

Objective

Eliminate ambient toxicity in Galveston Bay water and sediments by 2014.

Action WSQ-1: Reduce contaminant concentrations to meet standards and criteria.
Action WSQ-2: Determine sources of ambient toxicity in water and sediment.
Action WSQ-3: Establish and adopt sediment quality criteria.

Action WSQ-4: Perform TMDL loading for toxics by watershed.
Action WSQ-5: Support Clean Texas 2000 Pollution Prevention Program.

Priority Problem

Dissolved oxygen is reduced in certain tributaries and side bays, harming marine life. In most Galveston Bay waters, scattered violations of the dissolved oxygen standards (generally about 2 percent of the data show violations) indicate no serious or systematic water quality problems. Estuarine segments with some reported dissolved oxygen problems include Buffalo Bayou Tidal, Clear Creek Tidal, and Armand Bayou Tidal. Compared to the upper Houston Ship Channel, the other dissolved oxygen problems appear to be limited in scope and severity.

In the Houston Ship Channel above Morgans Point, however, there has been a historical problem with dissolved oxygen concentrations. In the 1960s and early 1970s, excessive point source discharges eliminated dissolved oxygen in the upper Ship Channel, virtually wiping out all aquatic life. Since 1968, however, there has been a 95 percent reduction in municipal and industrial point source BOD loadings, and the upper Ship Channel now has enough dissolved oxygen to support an "extensive" utilization of the Channel by numerous aquatic species.

Despite the dramatic reduction in municipal and industrial pollution between 1968 and 1990, however, there are still periodic low dissolved oxygen concentrations and exceedances in standards in the upper Houston Ship Channel. In Segment 1006 (San Jacinto River to Greens Bayou) the frequency of exceedance of the 2.0 mg/l dissolved oxygen standard has ranged between one and 12 percent since 1985. In Segment 1007 (Greens Bayou to I-59, including the Turning Basin) the frequency of exceedance of the 1.0 mg/l dissolved oxygen standard has ranged between one and six percent since 1985. Note that these stream segments have not been designated by the state to maintain aquatic life, and therefore the dissolved oxygen standards have been set lower than any other Galveston Bay segments (most of which have a 4.0 or 5.0 mg/l standard).

Goal

Increase dissolved oxygen in problem areas. The return of aquatic life to the upper Houston Ship Channel, even though the state has not designated that this segment should support aquatic life, has prompted interest in increasing the dissolved oxygen in the upper Houston Ship Channel. The problem of low dissolved oxygen in other areas is generally associated with inflow and wasteloads.

Objective

By 2004, ensure that all water quality segments within the estuary are in compliance with established dissolved oxygen standards.

Action WSQ-6: Reduce nutrient and BOD loadings to problem areas.
Action WSQ-7: Perform TMDL loading studies for oxygen-demand and nutrients by watershed.

Note: See Non-Point Source, Point Sources, and Public Health Action Plans for additional Water/Sediment Quality initiatives, including actions related to fecal coliform problems.

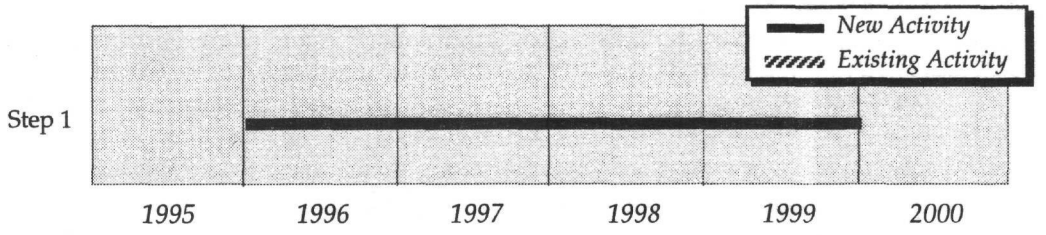
ACTION WSQ-2:
Determine Sources of Ambient Toxicity in Water and Sediment

What Determine the sources and pollutants which cause ambient toxicity in Galveston Bay. Perform correlation studies to determine if ambient toxicity is related to 1) sampling methods, 2) urban/industrial non-point runoff, 3) dredge material disposal, 4) point source discharges, including produced water discharge.

How

Step 1 TNRCC and USFWS will coordinate to design and perform loading studies on continuing sources of PCBs, DDT, PAHs, dioxins, selected heavy metals, and other toxics identified as part of Action WSQ-1 and identify potential sources of toxicity. The studies will 1) include detailed toxicity studies to resolve conflicting results from different methods; 2) include research to address the role of surface microlayer in ambient toxicity; 3) address the influence of pH, salinity, etc. on ambient toxicity; 4) determine the organisms and life stages affected by ambient toxicity focusing on the critical and most susceptible life stages; and 5) include assessment of biological community structure.

When



Where Begin with areas where ambient toxicity problems have been identified (see WSQ-1 and WSQ-3) and expand to areas where problems are suspected and/or where sufficient data has not been collected, as resources allow.

Who Lead entity: TNRCC and USFWS. Other participants: RRC, EPA, TPWD, USGS, Corps of Engineers, NPDES Storm Water permit groups, and industrial groups. Role of Galveston Bay Program: Coordination.

Public Costs of New Actions (5 years)

• Program	$ 15,000	• USFWS	$ 100,000
• TNRCC	$ 60,000		
TOTAL			**$ 175,000**

Private costs will probably be low as public funds will be used to conduct these studies. Potential Sources of Funding: NOAA, USGS, EPA, and TWDB.

Regulatory Issues None identified.

Related Actions: WSQ-1, WSQ-2, WSQ-3 WSQ-4, WSQ-5, NPS-1, NPS-3, NPS-6, NPS-8, NPS-9, NPS-13, NPS-16, HP-2, and PH-1.

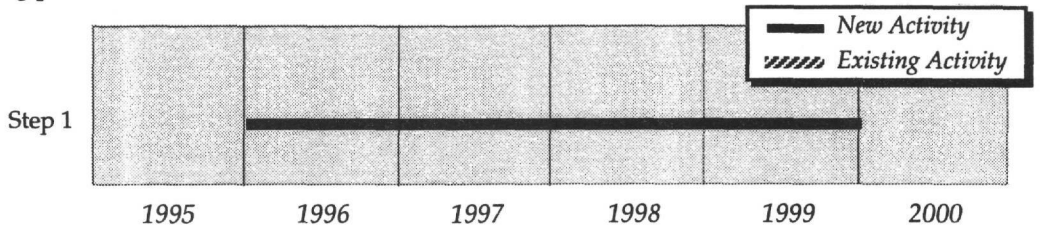
ACTION WSQ-3:
Establish and Adopt Sediment Quality Criteria

What Establish or adopt appropriate sediment quality criteria for PCBs, PAHs, metals, DDT, and other pollutants identified by ambient toxicity studies and by public health concerns.

How

Step 1 TNRCC will adopt sediment quality criteria based on 1) results of the ambient toxicity studies; 2) a review of criteria development options; and 3) value of establishing state criteria now vs. adopting EPA criteria at a later time. TNRCC will coordinate with ongoing federal development of sediment standards, and determine appropriate action levels for Galveston Bay risk assessments based on state and federal guidelines (i.e., 10^{-4} vs. 10^{-6} risk level). Need to inform public of reason why sediment standards are needed, what benefits are, and what are the potential costs. Need to develop appropriate sediment monitoring protocols. TNRCC will coordinate with GLO and TPWD.

When



Where All of Galveston Bay bottom sediments and sediments in tributaries to the limit of tidal influence.

Who Lead entity: TNRCC. Other participants: TPWD, USFWS, USGS, and GLO. Role of Galveston Bay Program: Coordination.

Public Costs of New Actions (5 years)

• Program:	$ 22,500
• TNRCC	$ 171,750
TOTAL	**$ 194,250**

Actions Tied to Other Programs: TNRCC may set sediment quality criteria regardless of implementation of *The Galveston Bay Plan*. Private Costs: Initially low. Future private costs to comply with sediment standards potentially high. Potential Sources of Funding: NOAA and EPA.

Regulatory Issues Need to add sediment criteria to state water quality standards.

Related Actions: WSQ-1, WSQ-2, WSQ-3 WSQ-4, WSQ-5, NPS-1, NPS-3, NPS-6, NPS-8, NPS-9, NPS-13, NPS-16, and HP-2.

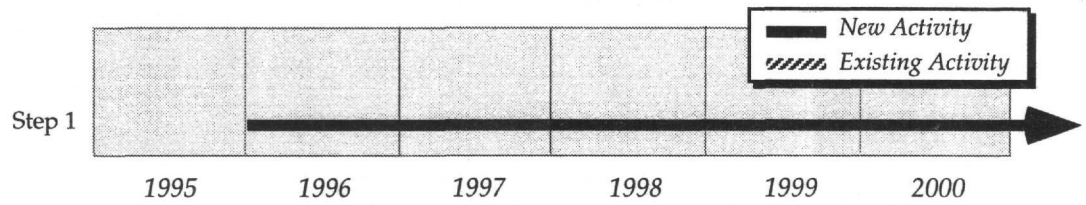
ACTION WSQ-4:
Perform TMDL Loading Studies for Toxics

What For existing developed areas, implement controls to satisfy water quality criteria using a TMDL (total maximum daily load) allocation process accounting for 1) point source loadings, 2) non-point loadings, 3) existing in-place sources such as sediments, and 4) other factors.

How

Step 1 TNRCC will perform TMDL studies to estimate total maximum daily load (including some consideration of non-point sources) to maintain ambient standards and incorporate this process into NPDES wastewater permits and storm water permits. Methods will be developed to integrate both point source and non-point sources into TMDL process. Additional research will be performed to quantify transport and fate of toxics in the bay.

When



Where All water quality segments not meeting standards, or where one might expect standards to be violated in future due to increasing point and/or non-point source impacts. Areas that have exhibited violations of water criteria are: Segment 1006 (HSC) for DDT; Segment 1007 (HSC/Buffalo Bayou) and Segment 1005 (HSC/San Jacinto) for water column PCBs. Using methods that overestimate actual concentrations, the existing data show potential criteria violations for dissolved heavy metals along the HSC (both open-bay and landlocked reaches), along the Intracoastal Waterway, and in turning basins.

Who Lead entity: TNRCC. Other participants: EPA, USFWS, USGS, and NPDES storm water permit holders. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 81,050
• TNRCC	$ 295,750
TOTAL	**$ 376,800**

Private Costs: Initially low. Future private costs to comply with sediment standards potentially high. Actions Tied to Other Programs: TNRCC already performs some toxics loading studies for dry weather conditions. Potential Sources of Funding: NOAA, USGS, EPA.

Regulatory Issues TMDLs should be added to the state's Water Quality Management Plan. Permits need to be revised when they come up for renewal based on results of TMDLs. Local storm water management plans might be required to meet pollutant loading goals. TNRCC must modify the TMDL process to account for point and non-point sources.

Related Actions: WSQ-1, WSQ-2, WSQ-3 WSQ-4, WSQ-5, NPS-1, NPS-3, NPS-6, NPS-8, NPS-9, NPS-13, NPS-16, PS-6, and PH-1.

ACTION WSQ-5:
Support Clean Texas 2000 Pollution Prevention Program

What Support the statewide pollution prevention program sponsored by the Governor and the TNRCC to reduce pollution across the state.

How

Step 1 Support the Clean Texas 2000 programs:

a. *Clean Industries 2000,* where industries will reduce the amount of hazardous wastes and/or emissions tracked by the Toxic Release Inventory Program by at least 50 percent by the year 2000, implement an internal environmental review program, form citizens' communications programs, and support community environmental projects

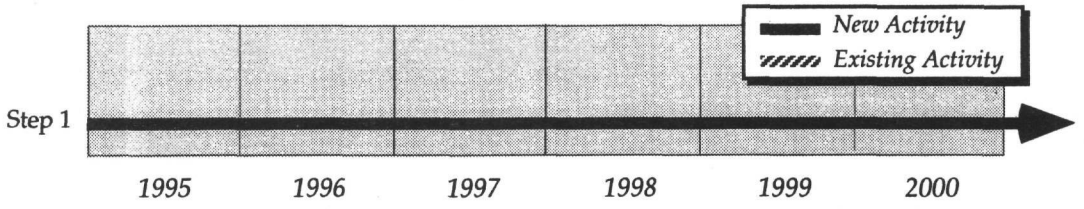
b. *Clean Cities 2000,* where cities will develop a comprehensive environmental program.

c. *Operation Paper Chase,* where the TNRCC will streamline its permitting and enforcement process and eliminate unnecessary levels of bureaucracy

d. *Texas Watch,* where citizens will be recruited and trained in water quality and environmental monitoring, local groundwater protection activities, and community collection of household hazardous waste

e. *Public Education,* where the TNRCC will give Texans practical information about what they can do to improve the environment (see Action PPE-3)

When



Where The entire Galveston Bay Program area.

Who Lead entity: Industries, cities, TNRCC, and citizens. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 22,500
TOTAL	**$ 22,500**

The TNRCC, several cities, and many private industries are currently participating in Clean Texas 2000 programs. No detailed cost expenditures are available.

Regulatory Issues None identified.

Related Actions: WSQ-1, WSQ-2, WSQ-3 WSQ-4, WSQ-5, NPS-1, NPS-3, NPS-6, NPS-8, NPS-9, NPS-13, SD-5, and PPE-3.

ACTION WSQ-6:
Reduce Nutrient and BOD Loadings to Problem Areas

What Reduce nutrient and BOD loadings to problem areas.

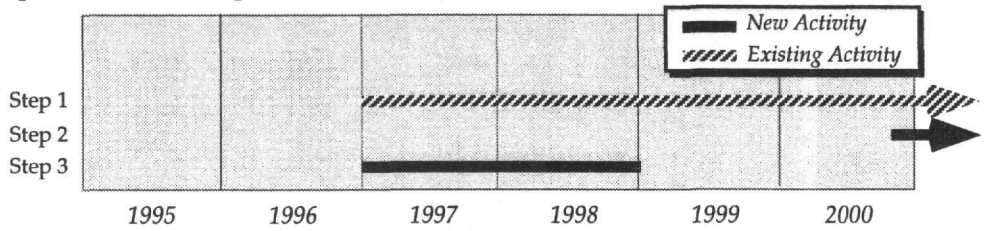
How

Step 1 TNRCC will coordinate with EPA to determine relative contributions of nutrients, oxygen-demanding materials, and hydrodynamic factors and identify most sensitive and most impacted areas, and then develop permissible nutrient and BOD loading rates based on the information.

Step 2 TNRCC and EPA will achieve necessary reductions in nutrient and BOD loadings through state and NPDES point source and storm water permit discharge programs using a technology-based strategy for implementation of best management practices. A synchronous schedule will be established for permit expirations on a watershed and subwatershed basis (subwatersheds such as Brays Bayou, Sims Bayou, Clear Creek, and Dickinson Bayou as listed in the GBNEP non-point source report).

Step 3 TNRCC will coordinate with EPA to conduct an engineering study (and/or attainability analysis) to determine if it is feasible to increase dissolved oxygen levels in the Houston Ship Channel The study will use monitoring, engineering analysis, and computer modeling. The study will include 1) sediment demand monitoring to determine sink effects of sediment; 2) determine change in dissolved oxygen concentrations in the Ship Channel during and after storm events (using existing or expanded USGS network); 3) develop cost vs. dissolved oxygen/frequency relationships; 4) determine relative contributions of nutrients and oxygen-demanding materials to problem; 5) determine limitations caused by the existing hydrodynamic regime of the channel; and 6) estimate benefits to aquatic life in Channel and to the entire bay system from increased dissolved oxygen concentrations. Specific monitoring and research tasks may be required to meet the goals of the study. If feasible, an aquatic life use designation for the Ship Channel will be pursued.

When



Where Generally in urbanized tributaries and bayous. Specifically, the upper Houston Ship Channel above Morgans Point, Buffalo Bayou Tidal, Clear Creek Tidal, and Armand Bayou Tidal.

Who Lead entity: TNRCC, EPA, USGS. Other participants: municipalities. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program ..... $ 107,250	• Others ..... $ 45,000
• TNRCC ..... $ 897,500	
TOTAL ..... $ 1,049,750	

Actions Tied to Other Programs: TNRCC already performs some loading studies for dry weather conditions. Private Costs: Initially low. Future private costs to comply with new standards potentially high. Potential Sources of Funding: NOAA, USGS, EPA, and TWDB.

Regulatory Issues No new legislation is required. Permit criteria may need to be revised based on results of this action. Thorough consistency reviews encourage reduction of discharge of nutrients by federally assisted or conducted actions. Consistency review of application for implementation grants from EPA can be used as a tool to encourage TNRCC to implement this action.

Related Actions: WSQ-7, NPS-1, NPS-2, NPS-3, NPS-4, NPS-6, NPS-7, NPS-8, NPS-9, NPS-10, NPS-11, NPS-12, NPS-13, PS-1, PS-2, PS-3, PS-4, and PS-5.

ACTION WSQ-7:

Perform TMDL Loading Studies for Oxygen Demand and Nutrients

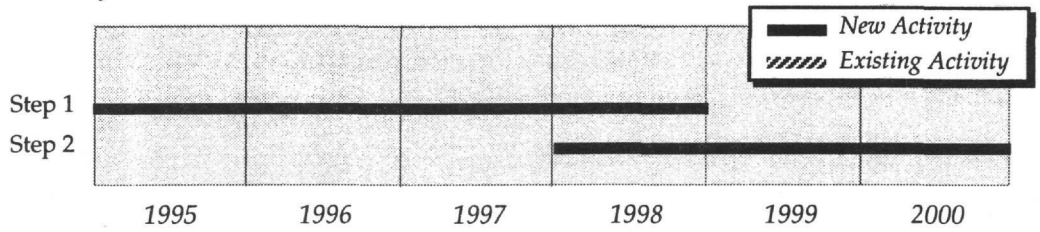
What For identified problem segments, implement controls to satisfy water quality criteria using a TMDL (total maximum daily load) allocation process accounting for both point and non-point loadings to the bay (see WSQ-4) for oxygen-demand and nutrients.

How

Step 1 TNRCC will perform TMDL studies to estimate total maximum daily load (or NPS equivalent) to maintain ambient standards and incorporate this process into storm water permits as NPDES moves from monitoring to storm water cleanup. TNRCC will modify TMDL process to account for point and non-point source loadings.

Step 2 TNRCC will require municipalities to perform engineering studies of existing drainage system to identify ways to retrofit system to reduce harmful effects from NPS.

When



Where Generally in urbanized tributaries and bayous. Specifically, the upper Houston Ship Channel above Morgans Point, Buffalo Bayou Tidal, Clear Creek Tidal, and Armand Bayou Tidal.

Who Lead entity: TNRCC. Other participants: EPA, USFWS, USGS, and NPDES storm water permit holders. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program .....$ 99,750	• Munis ..... $ 424,149
• TNRCC..... $ 1,437,500	
TOTAL..... $ 1,961,399	

Initially low. Future private costs to comply with new standards potentially high. Potential Sources of Funding: NOAA, USGS, EPA, and TWDB.

Regulatory Issues No new legislation is required. Permit criteria may need to be revised based on results of this action. TNRCC must modify the TMDL process to account for point and non-point sources.

Related Actions: WSQ-6, WSQ-7, NPS-1, NPS-2, NPS-3, NPS-4, NPS-6, NPS-7, NPS-8, NPS-9, NPS-10, NPS-11, NPS-12, NPS-13, PS-1, PS-2, PS-3, PS-4, and PS-5.

Non-Point Sources of Pollution

The Galveston Bay Plan
Galveston Bay National Estuary Program

OVERVIEW OF THE ACTIONS

THE ISSUES

One of the most difficult areas of environmental management is control of pollution leached from thousands of filling stations, residential yards, septic tanks, driveways, parking lots, industries, farms, and other sites of every-day human activity. Residential gardening and lawn care, car washing, storm sewer dumping, dockside activities, construction practices, agricultural runoff, septic tank leaks, and use of a wide array of consumer and commercial products introduce potentially harmful materials into Galveston Bay. Degradation of the bay is influenced by the presence of toxicants, sediment, bacteria and nutrients in runoff water from both urban and rural areas. Land development which eliminates wetlands further reduces the ability of runoff water to naturally cleanse itself as it proceeds to the bay.

A comprehensive action plan has been developed in *The Galveston Bay Plan* to resolve the major problems caused by non-point source pollution in the Galveston Bay system. Two

categories of non-point source pollution have been identified: contaminated runoff and boat sewage and debris. The goals of the actions directed towards contaminated runoff are to reduce the non-point source pollutant loads from urban, industrial, agricultural, and construction sources. Similarly, the goals of the actions addressing boat sewage and debris are to reduce marine sewage and runoff from boat maintenance operations. Initiatives proposed by *The Galveston Bay Plan* to reduce the harm caused by non-point sources of pollution include the following:

- Pollutant Load Reduction: Twelve actions in *The Galveston Bay Plan* recommend reducing non-point source pollutant loads from urban, industrial, agricultural, and construction sources. To achieve these reductions, programs and plans for the management of storm water, erosion, construction and other activities will need to be developed. Demonstration projects to evaluate best management practices for non-point source pollutant control techniques are encouraged. In general, *The Plan* advocates use of technology-based Best Management Practices rather than performance-driven regulatory approaches.

- Marine Sewage Reduction: *The Galveston Bay Plan* offers two actions for the reduction of sewage discharges generated by vessels and marinas. Discharge activities and their subsequent deleterious effects on aquatic life can be thwarted by the implementation of toxic and nutrient control practices and the establishment of enforceable requirements for marine sewage treatment.

- Management of Marina/Dockside Pollutants: Implementation of washdown controls and containment measures are advocated to reduce the release of harmful materials (e.g., paints, solvents, etc.) from marinas and docks in the Galveston Bay area.

ENVIRONMENTAL STATUS

Status and Trends

Non-point source pollution is more difficult to define than point source pollution, but in general can be described by these general characteristics:

- Non-point source discharges enter surface waters in a diffuse manner and at intermittent intervals that are related mostly to the occurrence of rainfall events.
- Pollution arises over an extensive area of land and is in transit overland before it reaches surface waters.
- Non-point sources generally cannot be monitored at their point of origin, and their exact source is difficult or impossible to trace.
- Elimination or control of pollutants must be directed at specific sites.
- In general, the most effective and economical controls are land management techniques and conservation practices in rural zones and architectural controls in urban zones.
- Compliance monitoring for non-point sources is conducted on land rather than in water.
- Non-point source pollutants cannot be measured in terms of effluent limitations.

- The extent of non-point source pollution is related, at least in part, to certain uncontrollable climatic controls, as well as geographic and geologic conditions, and may differ greatly from place to place and year to year.
- Non-point sources are derived from operations on extensive units of land, as opposed to industrial activities that typically operate on intensive (small) units of land.

Pollutants found in urban and rural runoff include toxics, fecal coliform bacteria, biochemical oxygen demand, nutrients, and sediments. The precise sources of non-point source loads are relatively difficult to determine due to their widespread diffuse nature. The following table identifies major potential sources of NPS pollutants:

Water Quality Parameter	Major Potential Non-Point Sources
Total Suspended Solids	Eroding urban areas, cultivated fields, and stream banks
Total Nitrogen	Eroding soils, fertilizer application, leaking sanitary sewers, overflows, bypasses, and natural organic matter
Total Phosphorus	Eroding soils, fertilizer application, leaking sanitary sewers, overflows, bypasses, and natural organic matter
Biochemical Oxygen Demand	Natural decaying organic matter, leaking sanitary sewers, overflows, bypasses, oil and grease, and natural organic matter
Oil and Grease	Motor vehicles
Fecal Coliforms	Leaking sanitary sewers, bypasses, overflows, malfunctioning septic tanks, pets, cattle, and wildlife
Dissolved Copper	Corrosion of copper plumbing, electroplating wastes, algaecides, and eroding soils
Pesticides	Urban and rural pesticide application

Galveston Bay National Estuary Program (GBNEP) Non-Point Source Study

The GBNEP Non-Point Source Project was designed to be a "washoff" study, in other words, a study of non-point source loads originating from different types of land use. Land use has been recognized as one of the major variables in non-point sources of pollution, and has been the focus of most of the non-point source studies performed in the country to date. An original land use/land cover database for Galveston Bay was developed from interpreted satellite imagery that provided a high resolution snapshot of the basin land use as it existed in 1990. In addition, a relatively new technology, Geographical Information Systems (GIS), was used to map the geographic characteristics of the study area, analyze the land use data, complete the NPS calculations, and to graphically present the project results.

To calculate non-point source loads from the basin, typical concentrations of each water quality constituent in runoff were estimated from a variety of local and nationwide data sources. These water quality data, defined as event mean concentrations (EMCs), were derived for each land use type defined for the Galveston Bay project (see table above).

The Houston area EMC database indicated that sediment, nutrient, and oxygen demanding substances in local urban runoff are typical of urban runoff in other parts of the country. Although the rural EMC data were not as extensive as the urban database, they indicated that

NPS concentrations from Galveston Bay agricultural areas are lower than many other parts of the country. One possible explanation is the extensive rice cultivation in the watershed; flooded rice fields generate relatively low concentrations of sediments and nutrients compared to typical row crops such as corn and soybeans.

In general, high density urban land use areas, such as industrial, commercial, multi-family residential, and transportation areas, had higher NPS pollutant concentrations than most other non-urban land uses. Forest lands had the lowest concentrations of pollutants in runoff.

Using the land use and event mean concentration data, annual non-point source loads calculated for the local watershed (downstream of Lake Houston and Lake Livingston) and the entire drainage to the bay were calculated for a year with average rainfall:

Parameter	**Annual Non-Point Source Loads Average Year (thousands kg/yr, except where noted)**	
	Study Area Only	**Entire Watershed**
Runoff (ac-ft: acre-foot)	3,010 ac-ft/yr	9,050 ac-ft/yr
Total Suspended Solids	481,000	581,000
Total Nitrogen	6,420	23,128
Total Phosphorus	1,110	3,711
Biochemical Oxygen Demand	26,300	46,500
Oil and Grease	14,200	14,200
Fecal Coliforms (CFU: Colony Forming Unit)	355×10^{15} cfu/yr	355×10^{15} cfu/yr
Dissolved Copper	10.9	34.0
Pesticides	0.8	1.5

Non-Point Sources Impacts

Non-point sources are known or suspected to be responsible for water quality impairment in several bayou, stream, and bay segments in the immediate Galveston Bay watershed. In 1993, the Houston Galveston Area Council (HGAC) published non-point source assessment reports that identified the following bay and tidal segments as having reported known non-point source impacts or having ambient water quality below existing standards:

Segment	Parameters of Concern	Data Source
Clear Creek Above Tidal*	Fecal Coliform, DO, Chlorides	HGAC
Clear Creek Tidal*	Fecal Coliform, Nutrients	TWC, GBNEP-22
Clear Lake*	Nutrients, Fecal Coliform	305b, GBNEP-22
Armand Bayou	Fecal Coliform	305b, GBNEP-22
Dickinson Bayou Tidal	Fecal Coliforms	GBNEP-22
Dickinson Bayou Above Tidal	Nutrients, Fecal Coliforms	TWC, 305b, GBNEP-22
Moses Lake	Fecal Coliforms (Oyster Standard)	TDH, GBNEP-22
Chocolate Bayou Above Tidal	Fecal Coliforms	GBNEP-22
Chocolate Bay	Fecal Coliforms, Metals	GBNEP-22
Upper Galveston Bay	Fecal Coliforms	TDH
West Bay	Fecal Coliform (Oysters), pesticides	TDH, GBNEP-22
Bastrop Bay	Metals	GBNEP-22

Lower Galveston Bay	Fecal Coliform (Oysters), Metals	TDH, GBNEP-22
Houston Ship Channel	Fecals, DO, metals, nutrients, O&G	HGAC, GBNEP-15/22
Buffalo Bayou Tidal	Fecals, DO, metals, O&G	HGAC, Sierra, SWCD
Tabbs Bay	Fecal Coliform	GBNEP-22
San Jacinto Bay	Fecal Coliform	GBNEP-22
Black Duck Bay	Fecal Coliform	GBNEP-22
Scott Bay	Fecal Coliform	GBNEP-22
Burnett Bay	Fecal Coliform	GBNEP-22
Barbours Cut	Fecal Coliform	GBNEP-22
Cedar Bayou Tidal	Fecal Coliform	GBNEP-22

Notes: DO = Dissolved Oxygen. O&G: Oil and Grease
Data Sources identified in References Section of HGAC Report.

In terms of impacts on living resources, some non-point source effects have been observed on fish populations and on benthic organisms (primarily bottom dwelling crustaceans and insects) in Galveston Bay. For example, in a study of 220 Galveston Bay fish kills over the past 20 years, a total of 43 fish kill events were attributed to low dissolved oxygen or other impacts from non-point sources. Non-point source-related fish kills most often occurred after heavy rains from June through September with a peak in August.

GBNEP conducted a sediment quality triad study of Galveston Bay where sediment samples were analyzed for contaminants, toxicity, and benthic abundance and diversity. This study analyzed six stations directly associated with urban and/or industrial runoff: Burnett Bay in the Houston Ship Channel, Kemah Flats near the Clear Lake outfall, near Texas City, Black Duck Bay near local industrial treatment lagoons by Baytown, Swan Lake, and Dollar Bay. Two of these stations, Burnett Bay and Black Duck Bay, had significantly altered levels of benthic organisms from "contaminant-induced degradation." Both of these small, partially enclosed bays are located on the upper Houston Ship Channel near urbanized and industrial areas. The other four urban/industrial stations did not exhibit a significantly altered benthic community as a result of contamination. Therefore the immediate effects of non-point sources on benthos appear to be concentrated in small enclosed bays near highly urbanized areas; in more open areas of the bay the effects of non-point sources are less pronounced.

Probable Causes

Relationship to Land Use

Urban land use areas were the main contributor of NPS loads from the study area for all the parameters. For example, the GBNEP non-point source loading study estimated that the urban areas in the local watershed (primarily the Houston metropolitan region) contributed over 43 percent of the total NPS sediment loadings, 55-65 percent of the NPS nutrient loadings, and over 85 percent of all of the fecal coliform, pesticides, and oil and grease coming from local non-point sources of pollution. In addition, urban non-point sources are important contributors of several priority pollutants (toxics) such as polynuclear aromatic hydrocarbons (PAHs) and heavy metals which can increase the health risk associated with consuming seafood from Galveston Bay. Many toxics, such as the PAHs, probably originate mostly from automobile and truck traffic.

The load maps produced for this project identified the locations of highly concentrated non-point source load generation. In general, the highly urbanized areas in the Houston metropolitan area, Baytown, Texas City, and Galveston show the highest loads per unit area for all of the water quality constituents. As would be expected, fecal coliform and oil and grease NPS loads are almost entirely derived from the urban areas. Urban areas were also shown to be high source zones for pesticides as well.

The non-point source maps indicate that the highest erosion rates and, consequently greatest sources of sediment, occur in a wedge-shaped area, having a point at the mouth of the Houston Ship Channel and reaching through Houston to the watersheds upstream of the Barker/Addicks reservoirs. The high sediment loads were attributed to eroding urban land areas in the Houston area and barren land in the rural western watersheds.

Marinas

Marinas also serve as non-point source discharges into the bay system, but are generally unregulated. In the Galveston Bay system, approximately 40 marinas with 9,171 wet slips were documented in 1987. Until recently there were few locations to pump out boat sewage and consequently, much of the boat sewage was directly discharged into Galveston Bay and Clear Lake. Recent studies have indicated that the water quality impact of marinas is localized within the immediate vicinity of the marina, with low dissolved oxygen values being observed. Elevated concentrations of copper, lead, and arsenic were also associated with marina sites.

Groundwater

A variety of activities has resulted in contaminated groundwater, some of which may discharge to local surface water. These activities include: 1) leaking underground storage tanks such as those associated with service stations, 2) industrial waste management activities, such as leaking sewers at petrochemical plants, and 3) abandoned waste disposal sites such as sites now managed under the Superfund Program. One recent groundwater discharge of contaminated groundwater from the Brio Superfund Site has resulted in a public health advisory for portions of Clear Creek.

Pathogenic Microorganisms in Runoff

Loading estimates developed in a GBNEP study indicated that non-point source runoff was probably the largest contributor of fecal coliforms (which are used as an indicator organism for the presence of pathogenic microorganisms and unsafe water) to Galveston Bay. Their study indicated that storm water runoff contributed several times the annual loadings of fecal coliforms than sewage treatment plant bypasses/overflows, septic tanks and other sources. One notable effect of fecal coliforms in runoff is that several streams appear to exceed the state water quality standards for contact recreation due to high concentrations of fecal coliform bacteria. Areas where the long-term fecal coliform bacteria levels exceeded the state standards for contact recreation are in western, developed tributaries of the bay: Buffalo Bayou, White Oak Bayou, Clear Creek, Dickinson Bayou, and Chocolate Bayou. Other reported problem areas include Moses Lake, Highland Bayou, and the Diversion Canal. In addition, non-point sources are probably responsible for the fecal coliforms counts that prevent oyster harvesting in some parts of the open bay. Note that while septic tanks contribute only a small fraction of

the overall fecal coliform export to the bay, they may be important sources for smaller, more enclosed areas. More information on fecal coliforms and related effects on public health is given in the Public Health Protection Action Plan, particularly with regard to potential problems of overestimating the health risk when using fecal coliforms as an indicator of unsafe water conditions.

General Impacts

Actual impacts of local NPS pollutants on the bay are difficult to assess without analyzing the change in pollutant concentrations in Galveston Bay itself. For example, NPS loads are relatively brief slugs of pollutants that enter the bay intermittently from numerous entry points in the presence of large volumes of runoff. The amount, timing, and duration of these NPS events are determined by rainfall conditions. Discharges from Lake Livingston and Lake Houston complicate this assessment, as the reservoirs change the timing and water quality of the discharge from the Trinity and San Jacinto rivers to the bay.

MANAGEMENT STATUS

A number of federal and state regulatory programs have been developed to control point and non-point sources of pollution. Point source pollution has been controlled since the passage of the Federal Water Pollution Control Act of 1972. Non-point source pollution is a general category for pollution that does not originate from a single location and is a major problem for many estuaries. Non-point sources include urban runoff, construction sites, septic tanks, waste disposal sites, agriculture, silviculture, and marinas. A depiction of the major non-point management program applicable to Galveston Bay is shown in Figure NPS-1. These programs are described in more detail in the following text.

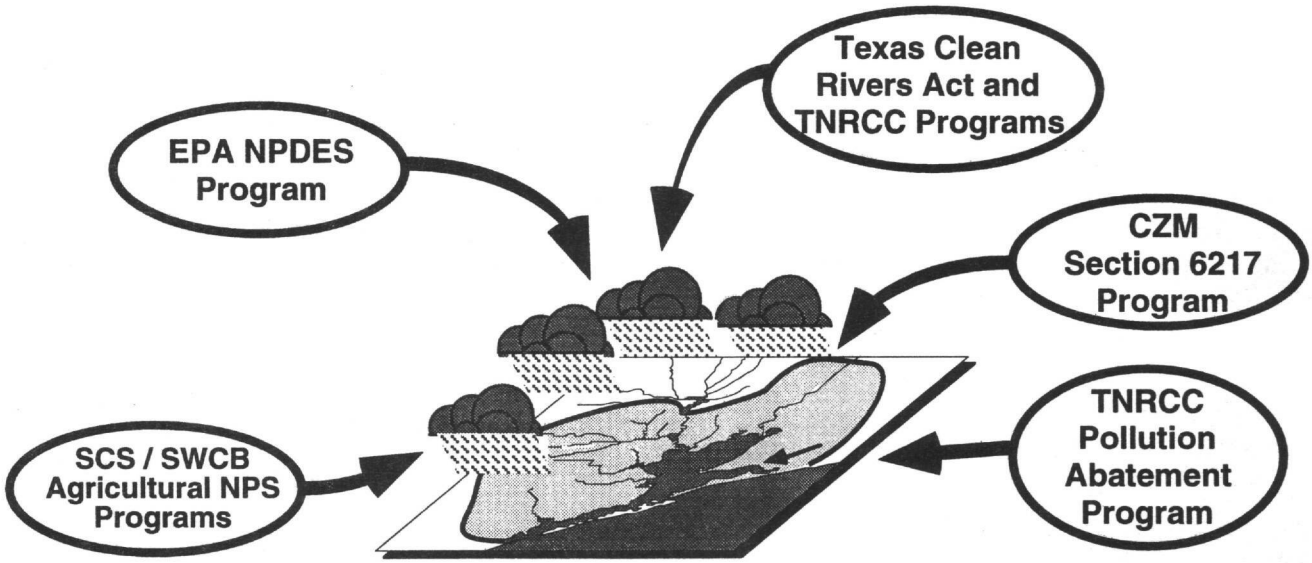


FIGURE NPS-1. Major Non-Point Source Management Programs That Are Applicable to Galveston Bay

Federal Programs

Clean Water Act Section 319

Section 319 of the Clean Water Act was the first national program to authorize federal funding for the control of non-point sources of water pollution and to support implementation of the states management programs. In order to be eligible for federal funding, states were required to:

- Assess water quality impacts due to non-point sources of pollution
- Develop a management program to address non-point source impacts

Section 319 authorizes the U.S. Environmental Protection Agency (EPA) to issue annual grants to assist states in implementing effective non-point source management activities that result in water quality improvements and other environmental benefits. The grants are offered on a 60 percent federal/40 percent local share matching basis to implement non-point source management programs and projects. The local share match requirement can be met in the form of "in-kind" services.

Clean Water Act Storm Water Permits

The storm water permits program was enacted by Congress under Section 402 of the Clean Water Act (CWA). The Phase I regulations require operators of municipal storm water systems with populations greater than 100,000 people and certain industrial operations (including large construction sites) to obtain a National Pollutant Discharge Elimination System (NPDES) permit from the EPA for their storm water outfalls. Permits are also to be issued, on a case-by-case basis, to storm water discharges contributing to a violation of a water quality standard or causing a significant amount of pollutants to enter surface waters.

In the Galveston Bay area, the following entities have submitted two-part applications to EPA for municipal storm water discharge permits: City of Houston, Harris County/Harris County Flood Control District, Texas Department of Transportation, and the City of Pasadena. The permit application was highlighted by the collection of storm water discharge characterization data and the development of a comprehensive Storm Water Management Plan (SWMP). The SWMP addresses the following: a comprehensive storm water monitoring program, a program to reduce pollutants in storm water runoff from commercial and residential areas, a program to detect and remove illicit connections to the storm sewer system, a program to monitor runoff from municipal landfills and certain industrial facilities, and a program to reduce pollutants in runoff from construction sites.

Coastal Zone Management Act

The federal Coastal Zone Management (CZM) Act of 1972 established a program for states and territories to voluntarily develop comprehensive programs to protect and manage coastal resources. Texas is presently developing the Texas Coastal Management Program which will be submitted to NOAA for approval of participation in the federal CZM program. States applying for acceptance into the federal program are required to develop programs that include enforceable policies to manage coastal land and water uses, that may adversely affect coastal natural resources. State programs are also required to include methods for resolving

conflicts among competing uses. Each program must protect and manage important coastal resources, including wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife habitats.

The Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) added Section 6217, a provision jointly administered by NOAA and EPA, which requires states with federally approved CZM programs to develop coastal non-point programs to address coastal non-point source pollution. The central purpose of Section 6217 is to strengthen links between federal and state coastal zone management and water quality programs. Section 6217 allows states to secure additional federal funding by participating in the federal CZM program to implement non-point source management measures in areas of the coast that significantly affect coastal waters. Participating states will be required to expand their non-point source programs that had been approved by EPA under Section 319 of the CWA and previously approved by National Oceanic and Atmospheric Administration (NOAA) under Section 306 of the CZM Act.

The coastal zone program requires EPA and NOAA to identify non-point source management measures and provide guidance on these measures to the states. Management measures are economically achievable measures for controlling non-point source pollution. The measures reflect the greatest degree of pollutant reduction achievable through the application of best available technology, siting criteria, operating methods, or alternatives. These measures are described in the *Guidance Specifying Management Measures for Sources of Non-point Source Pollution in Coastal Waters.* Participating states may select from a wide range of practices or a combination of practices that will achieve the level of control specified in the management measures.

The guidance addresses five categories of non-point source pollution: 1) agriculture, 2) forestry, 3) urban, 4) marinas, and 5) hydromodification. Example management measures include infiltration basins and trenches, vegetated filter strips, grassed swales, porous pavement, concrete grid pavement, water quality inlets, extended detention ponds, wet ponds, and constructed storm water wetlands.

This program is technology based, as opposed to water quality or performance based. In other words, unless the state can show that a category or subcategory does not individually or cumulatively, impact coastal waters, the measures *must* be implemented. The state must identify additional management measures for waterbodies that are impaired or threatened even after the prescribed management measures are implemented. Also, as with the CZM program, states must also have enforceable policies and mechanisms to ensure implementation.

The states also have the option of proposing alternative management measures. The measures prescribed in the guidance may not be feasible in all areas of the country. Therefore, states have the option of proposing alternative management measures. These measures must be shown to be as effective or better than those prescribed.

An issue for Galveston Bay is the applicability of Section 6217 guidance under the region's particular conditions of rainfall, topography, and soil types. Some of the management measures are not necessarily economical or technically feasible to implement in the local area. The state's current plans for the CZM do not include requirements for implementing the Section 6217 technical guidance, as other measures that achieve the same effect are to be developed. BMPs proven to be effective in the local area are summarized in the *Storm Water Quality Management Guidance Manual*, prepared by the Storm Water Joint Task Force comprised of Houston, Harris County, Harris County Flood Control District, and the Texas Department of Transportation. The Joint Task Force is using this manual as a basis for managing urban runoff in the Houston/Harris County NPDES permit area.

NOAA is authorized under Section 6217 to provide funds to state coastal management agencies to develop coastal non-point programs and funds may also be available from EPA under Section 319 of the CWA for implementation. In areas that are determined to be threatened or impaired by non-point source pollution despite the implementation of management measures, additional measures may be used. The state agencies with responsibility to abate non-point source pollution will identify the additional measures necessary to meet the state's water quality standards.

Agricultural Programs

Pollutants from agriculture may include sediments, nutrients, chemicals, salts, organic matter, and bacteria that can enter the Galveston Bay estuary suspended or dissolved in runoff, or attached to sediment particles. Agricultural sources of non-point source pollution include crop production, pastureland, rangeland, feed lots, aquaculture, and livestock management areas. The Agriculture Stabilization and Conservation Service (ASCS) and the Soil Conservation Service (SCS) of the U.S. Department of Agriculture administer a number of programs related to non-point source pollution from agricultural production. The ASCS administers two programs for ranchers and farmers, the Agricultural Conservation Program and the Conservation Reserve Program.

The Agricultural Conservation Program provides cost-share funds to farmers and ranchers to adopt conservation practices. These conservation practices are

- Conserve soil and water
- Improve water quality
- Protect and maintain productive farm and ranch land
- Preserve and develop wildlife habitat

The Conservation Reserve Program is designed to protect land that is easily eroded by retiring these areas from production for a period of 10 years. Decreased sediment loading to water occurs because of reduced soil erosion. The Conservation Reserve Program is also intended to protect and improve water quality by taking cropland out of production. Nonproductive cropland requires fewer fertilizers and pesticides; therefore, fewer of these pollutants are available for runoff.

The SCS provides technical assistance to conservation districts throughout the U.S. for water quality. The objectives of the SCS are to

- Increase technical assistance to areas with concerns about water quality
- Demonstrate available technology that will improve or protect water quality
- Help state agencies develop and implement programs for non-point source pollution
- Evaluate pollutant loads to determine the amount originated from agricultural sources
- Plan and implement a program of conservation practices to improve water quality affected by agricultural operations
- Evaluate the effects of conservation practices in reducing or preventing non-point source pollution

Other Federal Programs

The U.S. Geological Survey (USGS) and EPA have a Memorandum Of Understanding (MOU) pledging cooperation and collaboration on water quality monitoring and assessment activities. Both agencies conduct monitoring and assessment activities and the MOU coordinates their efforts.

The Forest Service also has a non-point source pollution management program that is coordinated with individual states to ensure compliance with state water quality requirements. Non-point source pollution that may result from land management activities is controlled by the following:

- Designing practices that are expected to meet water quality objectives
- Monitoring to ensure such practices are implemented and effective
- Mitigation to correct for unexpected problems
- Adjustment in land management design criteria where necessary

State Programs

Texas Clean Rivers Act

The Clean Rivers program was established by the Texas Natural Resource Conservation Commission (TNRCC) under provisions of the Texas Clean Rivers Act. The Act provides for a basin-wide comprehensive water quality management approach to evaluate cumulative impacts of point and non-point source pollution. The objectives of the Clean River program are to develop inventories of wastewater discharges, assess water quality status and trends, and evaluate cumulative impacts of point and non-point source pollution. Note that the Clean Rivers Program focuses on watersheds, but does not include an assessment of the Galveston Bay estuary.

TNRCC contracts with councils of governments or river authorities to perform comprehensive water quality assessments of river basins or watersheds. The assessments provide definitive technical information on non-point sources of pollution, nutrient loadings, and toxic materials, and the impacts and significance of this pollution on the health of aquatic life. Biennial reports will be prepared summarizing the results of the assessments, actions taken to address water quality, and recommendations on TNRCC's regional water quality management plans for each

basin or watershed. The program is funded by a state fee on wastewater discharge and water rights permits.

Texas Water Code Section 26.177

Section 26.177 of the Texas Water Code authorizes the TNRCC to develop rules requiring municipalities with populations of over 5,000 to develop and implement comprehensive water pollution control and non-point source pollution abatement plans. Promulgation of these rules is still pending.

Texas Agricultural Programs

Non-point source pollution from agricultural and silvicultural activities is managed by the Texas State Soil and Water Conservation Board (SWCB). The SWCB is in the process of establishing a certification program for non-point source pollution abatement plans developed for agricultural and silvicultural practices. The plans must comply with state surface water quality standards. The SWCB also works with the TNRCC to coordinate data collection and analysis for river basin and watershed assessments under the Texas Clean Rivers program.

The Texas Department of Agriculture (TDA) and the TNRCC have regulatory authority over the storage and disposal of pesticide wastes. TDA administers the state's pesticide and herbicide regulations developed under the Texas Pesticide Control Act and the Texas Herbicide Law. TNRCC has promulgated rules under the Texas Solid Waste Disposal Act prohibiting the storage, processing or disposal of any pesticide waste that may endanger human health or the environment. In addition, the Texas Department of Health regulates the labeling of pesticides and herbicides.

NON-POINT SOURCES ACTION PLAN

To reduce and eventually eliminate harm from non-point sources of pollution entering Galveston Bay, including toxic contaminants, nutrients, pathogens, sediment, and oxygen-demanding materials.

OVERVIEW

Priority Problem:

Contaminated runoff from non-point sources degrades the water and sediments of the bay tributaries and some near-shore areas. For example, over half of the sediment, phosphorus, fecal coliform bacteria, and oxygen demanding substances originate from non-point sources found in the local watershed. Although these NPS loads do not appear to be creating serious problems in the open bay (except for fecal coliforms), there are notable problems in urbanized bayous and enclosed areas with poor circulation. Specific problem areas include low dissolved oxygen in portions of the Houston Ship Channel, high fecal coliform concentrations that exceed contact recreation standards in Clear Creek and Dickinson Bayou, high nutrient concentrations in many of the urbanized bayous, and pollutants discharged from local marinas. These and other patterns were revealed in a comprehensive water/sediment quality study conducted by the University of Texas. General problems associated with non-point sources include closure of about half the bay to oystering due to high fecal coliform counts and polynuclear aromatic hydrocarbons (PAHs) from combustion sources that bioaccumulate in seafood.

Goal:

Reduce urban NPS pollutant loads. Urban non-point sources have been identified as the land use generating the highest NPS pollutant loadings to the bay. For example, the GBNEP non-point source loading study estimated that the urban areas in the local watershed (primarily the Houston metropolitan region) contributed over 43 percent of the total NPS sediment loadings, 55-65 percent of the NPS nutrient loadings, and over 85 percent of all of the fecal coliform, pesticides, and oil and grease coming from local non-point sources of pollution. In addition, urban non-point sources are important contributors of several priority pollutants (toxics) such as PAHs and PCBs which can increase the health risk associated with consuming seafood from Galveston Bay.

Objective:

Establish the regulatory framework for NPS control throughout the entire immediate Galveston Bay watershed within five years.

Action NPS-1: Implement storm water programs for local municipalities.
Action NPS-2: Perform pilot projects to develop NPS Best Management Practices.

Objective:

Reduce NPS loads from existing development. In particular, reduce PAH loadings from non-point combustion sources by 10 percent by 2004. If possible, reduce fecal coliform loadings (or appropriate indicators of pathogens) to 1) levels acceptable for contact recreation in Buffalo

Bayou, White Oak Bayou, Clear Creek, Dickinson Bayou, and Chocolate Bayou; and 2) levels that will permit opening of some or all of the open bay waters currently closed to oyster harvesting (see Public Health Protection Action Plan) by 2014.

Action NPS-3: Identify and correct priority watershed pollutant problems.
Action NPS-4: Establish residential load reduction programs.
Action NPS-5: Correct malfunctioning shoreline septic tanks.

Objective:

Reduce urban NPS loading from new development using technology-based best management practices. Pollutants of particular interest for open Galveston Bay waters are fecal coliforms. Other areas, such as watersheds draining into the Houston Ship Channel may require reductions in other parameters such as BOD, TSS, and nutrients as well (see Water Quality Action Plan).

Action NPS-6: Implement NPS Reduction Plan Program for New Development.
Action NPS-7: Establish Roadway Planning to Minimize NPS Effects.

Goal:

Reduce industrial NPS pollutant loads. Industrial non-point sources include runoff from some non-process areas, storage areas and other industrial land uses. Although there are no data regarding the percentage contribution of industrial non-point sources at this time, there is information that industrial NPS have had some impact to the bay over the past 40 years.

Objective:

Ensure implementation of existing NPS programs for industrial areas within five years.

Action NPS-8: Implement NPDES Storm Water Program for area industries.
Action NPS-9: Prevent degradation of bay waters by known industrial groundwater plumes.

Goal:

Reduce agricultural NPS pollutant loads. Although agricultural NPS loadings are thought to cause more limited problems to Galveston Bay than other watersheds, it is suspected that there are localized problems caused by agricultural land uses. Existing programs need to be implemented to meet existing water quality standards.

Objective:

Manage agricultural runoff to satisfy water quality standards within five years.

Action NPS-10: Develop inventory of agricultural non-point sources.
Action NPS-11: Coordinate and implement existing agricultural NPS control programs.

Goal:

Reduce construction NPS pollutant loads. Construction NPS loadings have been shown to cause localized deterioration of water quality in the Galveston Bay watershed and create aesthetic problems with regards to water clarity. Erosion control programs for construction sites are an accepted practice in many of the large metropolitan regions and several states. For Galveston Bay, erosion control practices now being implemented in Houston and Harris County and by the Texas

Highway Department need to be implemented in other construction sites in the local watershed. In addition, toxics and nutrients control programs for construction sites need to be established.

Objective:

Reduce erosion from construction sites to the maximum extent practicable within five years.

Action NPS-12: Adopt regional construction standards for NPS reduction.

Objective:

Limit migration of toxics and nutrients from construction sites within 10 years.

Action NPS-13: Implement toxics and nutrient control practices at construction sites.

Priority Problem:

Water and sediments are degraded in and around marinas from boat sewage and introduction of dockside wastes from non-point sources. One study has indicated that the combination of poor circulation and discharge from boaters and boat maintenance operations create serious localized water quality problems.

Goal:

Reduce marina water quality degradation associated with sewage. Currently many boaters discharge raw sewage from marine heads directly in the waters of Galveston Bay, causing potential problems with nutrients and bacteria. By eliminating sewage discharge, poor areas of water quality near the marinas and near discharge points will be eliminated.

Objective:

Achieve zero sewage discharge from marinas to surface water within 10 years.

Action NPS-14: Require sewage pumpout, storage, and provisions for treatment.
Action NPS-15: Require use of marine sanitary chemicals that can be treated in POTWs.

Goal:

Reduce marina/dockside NPS loads. Current boat maintenance operations create waste materials (some toxic) that wash off maintenance areas into the waters of Galveston Bay. Some of the these materials, such as tributyl tin (TBT) have been observed to accumulate in sediments of Galveston Bay. These discharges need to be eliminated to improve the water quality of the bay and protect marine life in the bay.

Objective:

Eliminate the release of harmful materials (paints, solvents, etc.) from marinas and docksides within 10 years.

Action NPS-16: Implement washdown controls and containment measures.

ACTION NPS-2:

Perform Pilot Projects to Develop NPS Best Management Practices for the Galveston Bay Watershed

What To support the bay-wide regulatory program, perform specific pilot projects to demonstrate viability of various best management practices for new development in Galveston Bay area. For example, some engineering practices related to detention and particularly infiltration technology are inappropriate for local topography, rainfall regimes, and soil types. Compile a single bay-wide BMP performance document based on performance data from the area and data that is transferable from other areas.

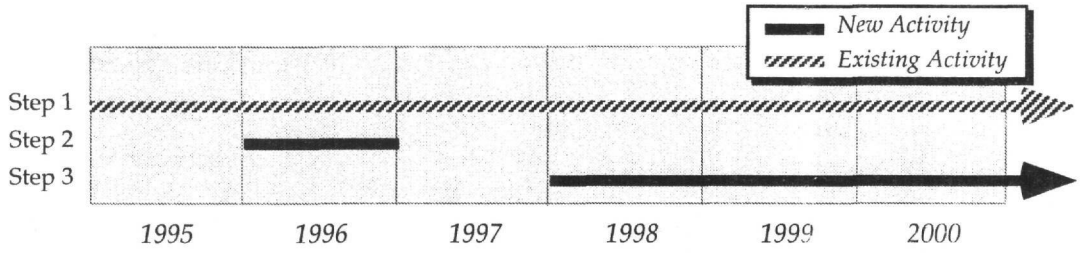
How

Step 1 TNRCC will establish Galveston Bay as a demonstration area for coastal urban NPS pollution abatement by adding newly-identified problem areas in the Galveston Bay watershed (NPS-3) to its Section 319 NPS Assessment Report to EPA. TNRCC will publicize this action so potential pilot project sponsors are aware of funding eligibility for Galveston Bay demonstration projects.

Step 2 Various entities will continue ongoing NPS projects and initiate new demonstration projects that include evaluation of BMPs in the Galveston Bay watershed.

Step 3 The Galveston Bay Program will compile a *Galveston Bay BMP Performance Document* to inventory NPS control techniques which have been evaluated and, if necessary, adjusted to make them appropriate for local conditions and needs.

When



Where Selected urban watersheds and subwatersheds in local Galveston Bay watershed.

Who Lead entities: Galveston Bay Program, TNRCC, and Houston/Harris County. Participants: HGAC, EPA, universities, USGS, GLO, consulting firms, and local municipalities. Role of Galveston Bay Program: Conduct Action.

Public Costs of New Actions (5 years)

• Program .....$ 37,500	• GLO, HGAC $ 30,000
• TNRCC ..... $ 1,328,750	• Munis ..... $ 90,000
TOTAL..... $ 1,486,250	

Private costs: low. Actions Tied to Other Programs: Some funding is currently committed to performing NPS pilot projects. Potential Sources of Funding: USDA, NOAA, HUD, USGS, EPA, and TWDB.

Regulatory Issues None identified.

Related Actions: NPS-1, NPS-3, NPS-4, NPS-6, NPS-7, NPS-12, NPS-13, WSQ-6, WSQ-7, SD-6, HP-4, HP-9, and PPE-7.

ACTION NPS-3:
Identify and Correct Priority Watershed Pollutant Problems

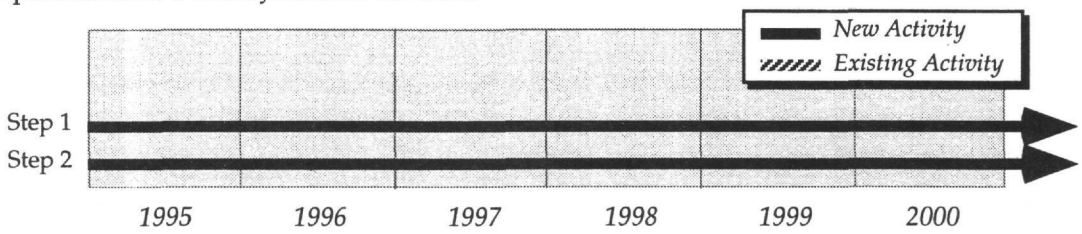
What Determine major source areas that cause excessive non-point source pollution to Galveston Bay. These zones of concern would include areas with bad erosion problems (such as eroding stream channels), areas with septic tank problems, and other bad management practices.

How

Step 1 The Galveston Bay Program will maintain and publish its own inventory of NPS concerns in the bay watershed. Various entities and researchers, through ongoing and new water quality initiatives, will continue to identify NPS source areas in the Galveston Bay watershed. Possible sources of information include 1) biennial basin assessment reports prepared under the Texas Clean Rivers Program will include a comprehensive inventory of NPS concerns in the watershed (not in the bay, however); 2) the GBNEP non-point source study's loading maps and land use maps; 3) 305b reports; 4) monitoring data showing areas with stream erosion problems, problem areas identified from agricultural non-point source programs, sources of continual PCB and PAH releases (if any); and the Galveston Bay Regional Monitoring Program. If necessary, special studies will be performed to locate and confirm the presence of non-point source areas and to perform in-stream ambient studies that will link loadings to real problems.

Step 2 Various entities, through ongoing and new water quality programs, will recommend the application of BMPs (NPS-2) or other appropriate NPS control measures (NPS-1, NPS-6) to respond to NPS source areas identified in the Galveston Bay watershed. The Galveston Bay Program could help to disseminate information on BMPs and other NPS control measures and recommend appropriate measures as needed. Galveston Bay Program also could report on NPS concerns and impacts in the Galveston Bay watershed through its publications and during State of the Bay Symposia. In addition, the Galveston Bay Council will evaluate the effectiveness of technology-based BMPs, and if insufficient water quality improvements have been observed after a five year period, it will work with local municipalities and the CCC to set up a workable performance-based system for the area.

When



Where Local Galveston Bay watershed. Areas with known non-point source impacts or ambient water quality exceeding water quality standards include: Clear Creek Above Tidal, Clear Creek Tidal, Clear Lake, Armand Bayou, Dickinson Bayou Tidal, Dickinson Bayou Above Tidal, Moses Lake, Chocolate Bayou Above Tidal, Chocolate Bay, Upper Galveston Bay, West Bay, Bastrop Bay, Lower Galveston Bay, Houston Ship Channel, Buffalo Bayou Tidal, Tabbs Bay, San Jacinto Bay, Black Duck Bay, Scott Bay, Burnett Bay, Barbours Cut, Cedar Bayou Tidal.

Who Lead entity: Galveston Bay Program. Other participants: HGAC, EPA, universities, USGS, SWCB, SCS, GLO, consulting firms, and local municipalities. Role of Galveston Bay Program: Conduct Action.

Public Costs of New Actions (5 years)

• Program	$ 50,000
• Munis	$ 775,000
TOTAL	**$ 825,000**

Private Costs: Initially low. Some landowners may have high costs if non-point source control measures are required to eliminate problems identified by this action. Potential Sources of Funding: USDA, SCS, NOAA, DoD, Corps, EPA, and TWDB.

Regulatory Issues None identified.

Related Actions: NPS-1 to NPS-13, WSQ-1 to WSQ-7, PS-3, PS-4, PPE-6, PPE-8, HP-3, HP-9, SD-6, PH-2, and PH-3.

ACTION NPS-4:
Establish Residential Load Reduction Programs

What Reduce NPS loadings from residential activities, including lawn and garden activities, household hazardous wastes, automotive fluids, pets, and storm sewer dumping.

How

Step 1 Galveston Bay Program will implement a Galveston Bay public education program aimed at NPS pollution reduction from residential areas in coordination with similar NPS educational efforts.

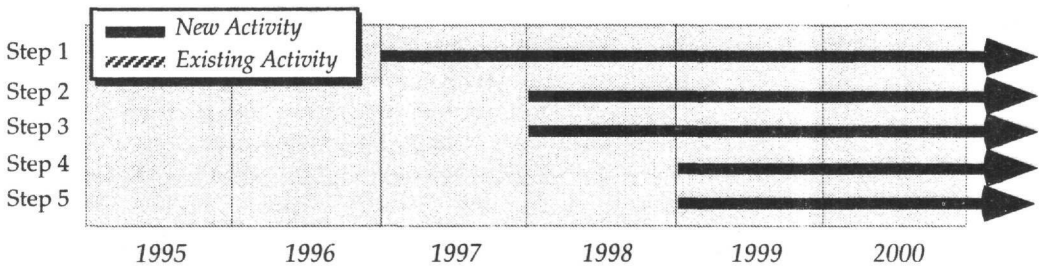
Step 2 Galveston Bay Program will complete an inventory of existing local government initiatives to reduce NPS pollution within their jurisdictions and assess technical assistance needs.

Step 3 TNRCC will complete an internal review of requirements it imposes on and associated funds it targets toward local governments for implementation of NPS pollution prevention measures to determine the need for program adjustments.

Step 4 The results of steps 2 and 3 will contribute to the development of local NPS management strategies under Action NPS-3.

Step 5 Galveston Bay Council will evaluate the effectiveness of its NPS Residential Load Reduction Program. If insufficient water quality improvements have been observed after a five year period, the Galveston Bay Program will work with local municipalities and the GLO to set up a workable performance-based system for the area.

When



Where Residential areas that drain into bay tributaries that show proven detrimental effects from non-point sources based on in-stream data during storm events. Potential problem areas include the following subwatersheds in the GBNEP non-point source report (GBNEP-15, Table III. 2) with over 20 percent residential areas: Addicks Reservoir AD02; Armand/Taylor Bayou AT04; Buffalo Bayou BF02, BF03, BF04, and BF05; Brays Bayou BR03, BR04, BR05, BR06, BR07; Cedar Bayou CE04; Greens Bayou GR02, GR03, GR05, GR06, GR07; Ship Channel SC01, SC02, SC03, SC05; and Sims Bayou SM03, SM04, SM05.

Who Lead entities: TNRCC and Galveston Bay Program. Other participants: EPA, GLO, local municipalities, local school districts, and environmental organizations. Role of Galveston Bay Program: Conduct Action.

Public Costs of New Actions (5 years)

• Program ..... $ 93,750	• HGAC ..... $ 24,000
• Munis .....$ 132,000	• Counties.....$ 582,600
TOTAL..... $ 832,350	

Private Costs: Initially low. Some landowners may have high costs if non-point source control measures are required to eliminate problems identified by this action. Actions tied to other programs are for programs proposed by the TNRCC. Potential Sources of Funding: USDA, SCS, NOAA, DoD, Corps, EPA, and TWDB.

Regulatory Issues May lead to new local ordinances aimed at curbing non-point source pollutants from various residential sources, such as fertilizer application, herbicide application, and pet waste. Through consistency review of implementation grants for TNRCC programs, the enhancement of existing or development of new TNRCC ordinances and education programs can be encouraged.

Related Actions: NPS-1, NPS-2, NPS-3, NPS-6, NPS-7, WSQ-6, WSQ-7, SD-6, and SD-7.

ACTION NPS-5:
Correct Malfunctioning Shoreline Septic Tanks

What Implement measures to reduce fecal coliform pollution to the bay from malfunctioning septic tanks.

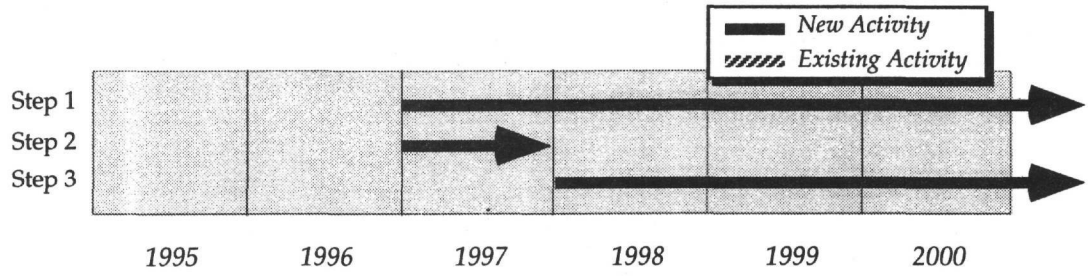
How

Step 1 Local counties will work with the Corps and the GLO to develop ordinances that require all shoreline septic tank systems meet statewide suggested septic system and lot size standards. Included in these ordinances will be education requirements for septic tank installers.

Step 2 Galveston Bay Program will work with the five counties and conduct a bay-wide septic system and geologic survey for use in regulations and management. The survey will also identify problem areas where septic tanks are degrading water quality through bacterial pollution.

Step 3 Local counties will require septic system certification and upgrades (if necessary) upon sale or transfer of property in problem areas identified in Step 2.

When



Where Areas affected by fecal coliform pollution from septic tank systems, primarily tributaries and areas with low circulation.

Who Lead entities: County health departments, Corps, GLO, and Galveston Bay Program. Other participants: EPA, TDH, TPWD. Role of Galveston Bay Program: Conduct Action.

Public Costs of New Actions (5 years)

• Program	$ 25,000
• Munis, Counties	$ 75,000
TOTAL	**$ 100,000**

Private Costs: High for some septic tank owners and some developers.

Regulatory Issues Stronger local ordinances will be required to curb fecal coliform pollution from septic tanks. These ordinances will require some type of certification and upgrades upon sale or transfer of property in problem areas.

RELATED ACTIONS: NPS-1, NPS-2, NPS-3, NPS-4, NPS-6, NPS-7, NPS-14, NPS-15, PS-1, PS-2, PS-5, PH-1, PH-2. AND PPE-3.

ACTION NPS-6:

Implement NPS Reduction Plan Program for New Development

What States with CZM programs that have received federal approval must develop a Coastal Non-Point Source Pollution Control Program. This program is designed to bring together the current patchwork of regulatory agencies to jointly address the problems of coastal non-point source pollution.

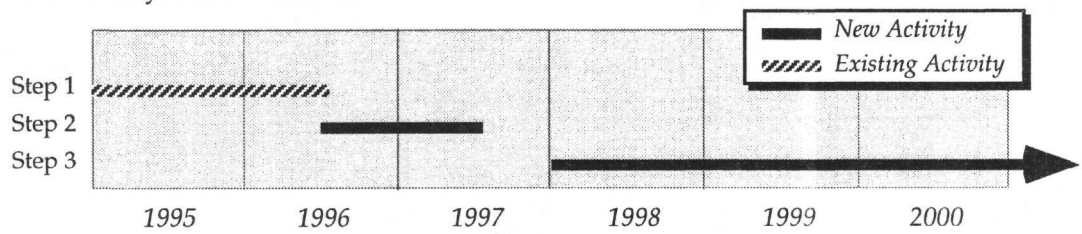
How

Step 1 CCC will oversee development of the Texas Coastal NPS Reduction Plan required under the CMP.

Step 2 The CCC will submit the proposed Texas Coastal NPS Reduction Plan to EPA and NOAA approximately two years after the CZMA, upon approval of the state's coastal management program for acceptance into the federal CZM program.

Step 3 The CCC will oversee implementation of the approved Texas Coastal NPS Reduction Plan (if adopted). State agencies and local governments will exercise their existing authorities to implement the Coastal NPS reduction plan. Note that Phase I storm water cities (such as Houston) are exempt under *The Galveston Bay Plan*, as they are developing similar programs under the NPDES Storm Water permitting process. A possible resource for the Texas program in the Galveston Bay area may be the best management practices included in the *Storm Water Quality Management Guidance Manual* prepared by the Storm Water Joint Task Force. These management measures are technology-based procedures and practices for controlling non-point source pollution that are effective with the area's combination of flat topography, heavy soils, and wet climate. Some research monitoring may be needed for to ensure that the various best management practices are effective in the Houston area. Galveston Bay Council will evaluate the effectiveness of the management measures. If insufficient water quality improvements have been observed after a five year period, the Galveston Bay Program will work with local municipalities and the GLO to set up a workable performance-based system for the area.

When



Where Entire local Galveston Bay watershed.

Who Lead entities: CCC, TNRCC, and SSWCB. Other participants: EPA, USGS, NOAA, GLO, TSDOT, local municipalities, marina owners, construction companies and developers, and industries. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

No new Costs	
TOTAL	**$ -0-**

Private Costs: Initially low. Implementation may involve high costs for developers and landowners. No new public costs were identified, as existing or planned programs are already in place for this action. Potential Sources of Funding: USDA, NOAA, EPA, DOT, ISTEA, and TWDB.

Regulatory Issues Texas NPS Reduction Plan Program will need to be approved by EPA and NOAA.

Related Actions: NPS-1, NPS-2, NPS-3, NPS-4, NPS-7, WSQ-1, WSQ-2, WSQ-3, WSQ-4, WSQ-5, WSQ-6, WSQ-7, SD-6, SD-9, SM-2, PH-2, PH-3, PPE-3, PPE-4, and PPE-7.

ACTION NPS-7:
Establish Roadway Planning to Minimize NPS Effects

What Establish roadway planning to minimize NPS effects, including non-federal projects. This includes planning measures to protect areas that are susceptible to erosion, limit the disturbance of natural drainage features, etc.

How

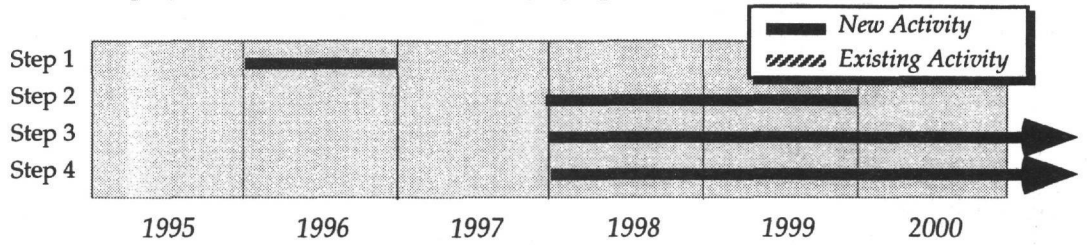
Step 1 Galveston Bay Program and the TXDOT will work together to incorporate into the 1996 State of the Bay Symposium any research findings and activities on NPS management issues related to roadway planning and design. Management measures in the *Storm Water Quality Management Guidance Manual* prepared by the Storm Water Joint Task Force may be used as a resource for appropriate best management practices.

Step 2 Galveston Bay Program and the TXDOT will work together to organize educational workshops for county highway agencies, municipal public works departments, and private transportation engineering consultants in the Galveston Bay area regarding NPS control and prevention in roadway planning, design, construction, operation and maintenance.

Step 3 Galveston Bay Program and the TXDOT will work together to promote demonstration projects and case studies of successful incorporation of NPS control and prevention measures into roadway planning and design.

Step 4 TXDOT and other roadway planning interests will continue to present results of NPS control research and demonstration projects at biennial State of the Bay Symposia.

When



Where Entire local Galveston Bay watershed.

Who Lead entities: Galveston Bay Program and TXDOT. Other participants: USDOT, county highway departments, local municipalities, and TNRCC. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program ..... $ 7,500	• Counties ..... $ 47,250
• TXDOT ..... $ 111,250	
TOTAL ..... $ 166,000	

Private Costs: Initially low. Potential Sources of Funding: EPA, DOT, ISTEA, and TWDB.

Regulatory Issues Need to change management priorities within roadway planning agencies. Consistency review of highway research, planning, and construction grants provided by DOT can encourage use of best available technology and practices to reduce TSS, non-point source loading from new highway developments.

Related Actions: NPS-1, NPS-2, NPS-3, NPS-4, NPS-6, WSQ-6, WSQ-7, SD-6, PPE-7, SM-1, SM-2, PH-1, PH-2, and PH-3.

ACTION NPS-8:

Implement NPDES Storm Water Program for Area Industries

What Continue to implement NPDES storm water program for area industries identified by federal regulations. During Phase II of the program additional industries will be identified. The industrial storm water permitting program is an EPA pollution control initiative that consists of the following elements: monitoring plans, pollution prevention plans, and spill prevention plans. Subsequent portions of the program will aim at managing problem non-point sources from industrial sites.

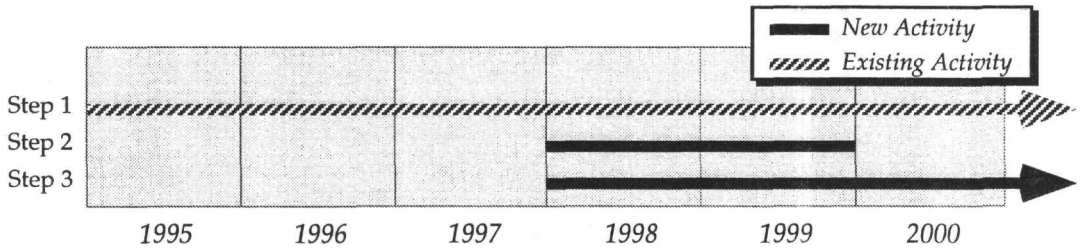
How

Step 1 Galveston Bay Program will monitor the efforts of industries within the Galveston Bay watershed to meet the requirements of the federal storm water permit program and implement effective storm water management and pollution prevention plans. Galveston Bay Program will provide input as needed based on scientific and public policy studies completed for *The Galveston Bay Plan.*

Step 2 Galveston Bay Program will work with the EPA to compile industrial non-point source monitoring data to update Galveston Bay NPS loading estimates and to assess industrial contributions to overall loadings.

Step 3 Galveston Bay Program will incorporate industrial Best Management Practices into the Galveston Bay BMP Performance Document to be prepared under Action NPS-3.

When



Where All industries in the local Galveston Bay watershed subject to the EPA's NPDES requirements.

Who Lead entity: EPA or TNRCC and regulated industries identified by federal regulations in NPDES industrial storm water permit program. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 21,750
TOTAL	**$ 21,750**

Private Costs: Existing compliance costs are moderate to high. Potential Sources of Funding: EPA, and TWDB.

Regulatory Issues Consistency review of application for NPDES implementation grants can be used to encourage efforts toward goals of *The Plan* once TNRCC has NPDES delegation.

Related Actions: NPS-3, WSQ-1, WSQ-2, WSQ-3, WSQ-4, WSQ-5, WSQ-6, WSQ-7, SM-1, SM-3, and HP-4.

ACTION NPS-9:

Prevent Degradation of Bay Waters by Known Industrial Groundwater Plumes

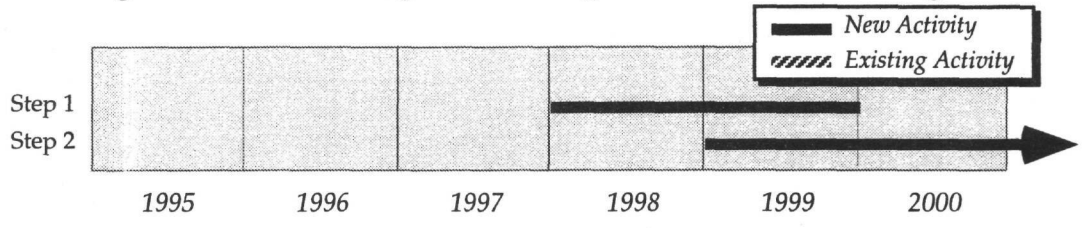
What Prepare inventory of known groundwater problems from active and abandoned industrial sites that could impact the bay. Note that this effort will not focus on septic tanks, as characterization studies have indicated that septic tanks are not a significant contributor to the annual bacterial loading to the bay.

How

Step 1 The TNRCC will lead an interagency effort to inventory groundwater impacts to the bay from industrial sources (active and inactive) and potential impacts on surface water via groundwater. This inventory will include all existing sites regulated under CERCLA, RCRA, the Leaking Petroleum Storage Tank Program, the Oil Pollution Act and the Clean Water Act which currently have confirmed groundwater plumes that may discharge into surface waters of the Galveston Bay watershed. The inventory will be based on data and reports from existing groundwater monitoring programs; no new monitoring programs will be mandated. The inventory will include an evaluation of the overall pollutant loading from groundwater sources to Galveston Bay.

Step 2 Based on the results from the inventory, TNRCC will require immediate remediation measures at sites that violate existing risk assessment rules, groundwater regulations, or surface water regulations.

When



Where All active and abandoned industrial sites with known groundwater contaminants that may impact Galveston Bay.

Who Lead entities: TNRCC and local industries with known groundwater problems. Other participants: HGAC, River Authorities, and USGS. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program ..... $ 4,500	• River Au..... $ 30,000
• TNRCC ..... $ 315,000	• HGAC..... $ 15,000
TOTAL..... $ 364,500	

Private Costs: Initially low. Some industries may have high costs to correct groundwater problems that are currently impacting the bay. Actions tied to other programs are proposed studies to be conducted as part of the Texas Clean Rivers Act. Potential Sources of Funding: USGS, EPA, and TWDB.

Regulatory Issues Change TNRCC's management emphasis to increase resources devoted to identifying groundwater plumes with substantial discharges to surface water. Consistency review of application for NPS implementation grants can be used to encourage TNRCC to move toward implementation of such programs.

Related Actions: NPS-3, WSQ-1, WSQ-2, WSQ-3, WSQ-4, WSQ-5, WSQ-6, WSQ-7, and SM-3.

ACTION NPS-10:
Develop Inventory of Agricultural Non-Point Sources

What Develop more accurate estimates of agricultural non-point source pollution to Galveston Bay.

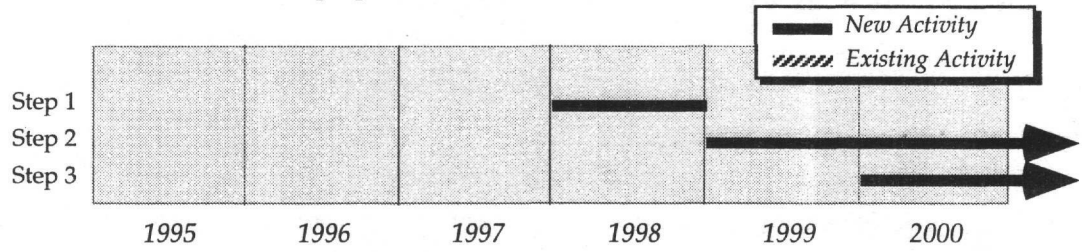
How

Step 1 The Texas State Soil & Water Conservation Board (SWCB) will lead an interagency effort to assess agricultural non-point source loadings to and impacts on Galveston Bay. Special studies will be performed to 1) refine current pesticide loadings from agricultural areas; 2) develop detailed loading estimates from the upper San Jacinto watershed (upstream of Lake Houston dam) and the upper Trinity watershed (upstream of Lake Livingston dam); 3) determine overall contribution of rice farming vs. low-till vs. conventional farming techniques; 4) assess seasonal effects to identify periods when high pollutant loads would be expected, such as when rice fields overflow or are drained, tilling periods, and periods when pesticide and fertilizer applications are heavy; 5) evaluate effectiveness of agricultural BMPs to reduce non-point source erosion loadings, 6) determine contribution of agricultural activities on fecal coliform levels in waters of Galveston Bay.

Step 2 SWCB will lead an interagency effort to evaluate the effectiveness of existing agricultural Best Management Practices in the Galveston Bay vicinity and recommend improvements based on local conditions and practices.

Step 3 Galveston Bay Program will incorporate agricultural Best Management Practices into the Galveston Bay BMP Performance Document to be prepared under Action NPS-3.

When



Where Agricultural areas in local Galveston Bay watershed.

Who Lead entities: SWCB, SCS, and HGAC. Other participants: River Authorities, local farming organizations, EPA, TNRCC, USGS, and GLO. Role of Galveston Bay Program: Coordinating.

Public Costs of New Actions (5 years)

• Program ..... $ 42,500	• Counties ..... $ 33,750
• TNRCC..... $ 312,500	• SWCB ..... $ 75,000
TOTAL..... $ 463,750	

Private Costs: Low to moderate. Actions Tied to Other Programs: Includes funding for Clean Rivers Act. Potential Sources of Funding: USDA, SCS, EPA, and TWDB.

Regulatory Issues Consistency review of application for implementation grants for NPS program can be used to encourage TNRCC to develop this inventory.

Related Actions: NPS-3, NPS-11, WSQ-6, and WSQ-7.

ACTION NPS-11:
Coordinate and Implement Existing Agricultural NPS Control Programs

What Coordinate with USDA water quality initiatives, State Soil and Water Conservation Board programs, SCS activities and programs, the Farm Assist Program, the Rural Clean Water Program, the Conservation Reserve Program, the Wetlands Reserve Program, EPA 319 funding, and other activities directed at agricultural sources of contaminated runoff.

How

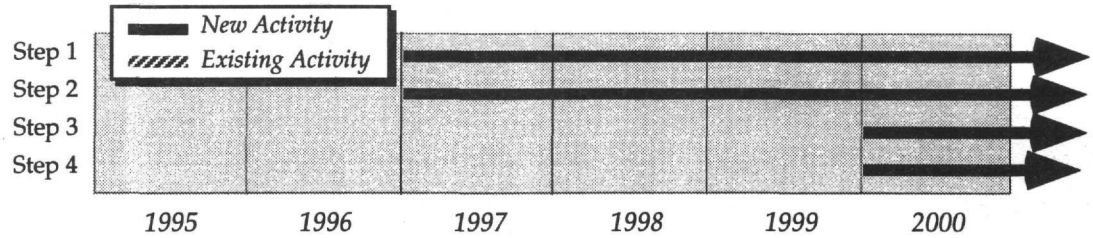
Step 1 The GBP will establish an Agricultural NPS Coordination Committee. This committee will include representatives of the SCS, the SWCB, the Texas Department of Agriculture, TNRCC, and other appropriate federal, state, local and private entities.

Step 2 The Agricultural NPS Coordination Committee will discuss and recommend priorities for 1) implementation of NPS-10; 2) coordination needs among agricultural NPS agencies and programs; and 3) possible joint projects between agencies/programs. The committee will consider other topics and coordination projects as needed, such as the need for increasing funding for agricultural NPS programs.

Step 3 GBP and the Agricultural NPS Coordination Committee will conduct educational workshops in the Galveston Bay watershed on agricultural NPS pollution and best management measures for the area (based on the results of the agricultural BMP evaluation to be completed under Action NPS-10). Educational programs may be coordinated with chemical supply stores, garden shops, schools, etc.

Step 4 The Agricultural NPS Coordination Committee will assist the GBP to incorporate agricultural Best Management Practices into the Galveston Bay BMP Performance Document to be prepared under Action NPS-2.

When



Where The local Galveston Bay watershed

Who Lead entity GBP. Other Participants: SWCB districts, USDA, SCS, Clean Rivers Act Studies, Farm Assist, Rural Clean Water Program, Conservation Reserve Program, Wetlands Reserve Program, EPA, TDA, TNRCC Ag program (under MOU negotiation between SWCB and TNRCC), Clean Rivers, and GLO. Role of GBP: Coordinating.

Public Costs of New Actions (5 years)

• Program	$ 22,500
• SWCB	$ 36,000
TOTAL	**$ 58,500**

Private Costs: Initially low. Actions tied to other programs are existing programs that include coordination activities by SWCB, GLO, and TNRCC. Potential Sources of Funding: USDA, EPA, EPA, and TWDB.

Regulatory Issues Some change in management decision-making process needed to increase coordination between various programs in different agencies.

Related Actions: NPS-3, NPS-10, WSQ-6, WSQ-7, HP-4, HP-9, FW-2, and PH-1.

ACTION NPS-12:

Adopt Regional Construction Standards for NPS Reduction

What On a regional basis by regulation, adopt and support the *Storm Water Management Handbook for Construction Activities* prepared by the Houston/Harris County Joint Storm Water Management Task Force for construction activities disturbing five or more acres or projects which are part of a master planned development.

How

Step 1 HGAC will continue to encourage implementation of NPS control measures during construction through its educational and outreach efforts to local governments and builder/contractor groups, through ongoing distribution of H-GAC's *Action Guide for Erosion and Sediment Control During Construction Activities*, and through its comments on projects evaluated through the review process.

Step 2 HGAC will encourage coordination among agencies with NPS programs to establish regional NPS control requirements or guidelines for construction activities in the Galveston Bay watershed. These requirements will be based, where appropriate, on the *Storm Water Management Handbook for Construction Activities* prepared for the Houston/Harris County/HCFCD/TXDOT Joint Storm Water Management Task Force. This will establish uniform construction NPS management practices for the entire region based on local conditions and practices. Note that since TXDOT is now a member of the Joint Task Force, the Handbook will be revised to reflect their guidance.

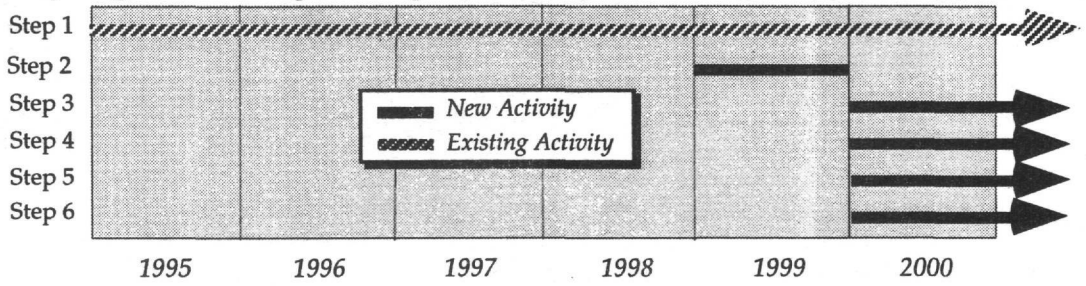
Step 3 Galveston Bay Program will work with other agencies to provide technical assistance to local governments on appropriate NPS controls and model guidance for construction activities.

Step 4 Galveston Bay Program will work with other agencies and builder/contractor groups to develop a regional education initiative for developers and contractors on construction BMPs.

Step 5 Galveston Bay Program will lead an interagency effort to conduct a comprehensive review of regional NPS control practices for construction activities. This review will incorporate the results of any BMP evaluation projects completed under Action NPS-2 which involve construction.

Step 6 Galveston Bay Program will incorporate Step 5 into the Bay BMP Performance Document (Action NPS-2).

When



Where Local Galveston Bay watershed.

Who Lead entities: HGAC, TNRCC, local municipalities, and Galveston Bay Program. Others: GLO (CMP), EPA/TNRCC (NPDES), and Joint Storm Water Management Task Force. Role of Program: Conduct Action.

Public Costs of New Actions (5 years)

• Program..... $ 37,500	• HGAC..... $ 37,500
• TNRCC ..... $ 15,000	
TOTAL.....	$ 90,000

Private Costs: moderate costs to developers, contractors. Potential funding sources: USDA, EPA, DOT, TWDB.

Regulatory Issues No new regulatory authority needed for existing NPDES storm water programs. Other municipalities need to adopt ordinances to implement these measures. Counties have no ordinance-making powers. Regulation would have to occur based on local ordinance-making powers. This action may require changes in local drainage regulations, codes, and zoning plans.

Related Actions: NPS-1, NPS-2, NPS-3, NPS-13, WSQ-6, WSQ-7, PPE-8, and SM-1.

ACTION NPS-13:
Implement Toxics and Nutrient Control Practices at Construction Sites

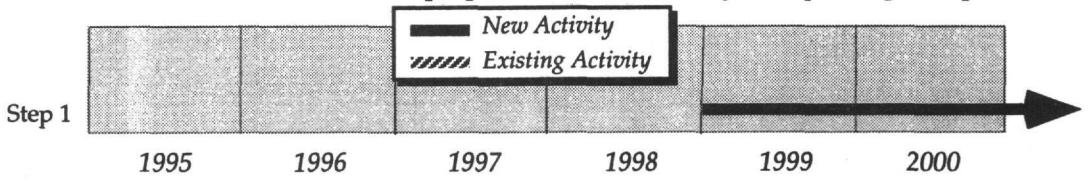
What Implement construction site chemical control measures as described in the CZM Non-Point Source Reduction Program (see Section 6217 *Guidance Specifying Management Measures for Sources of Non-Point Source Pollution in Coastal Waters*) that are appropriate to the Galveston Bay area. Note that Phase I storm water entities (such as Houston) are exempt, as they are developing their own NPS control program under NPDES.

How

Step 1 CCC will encourage coordination among agencies with NPS programs to establish regional requirements or guidelines for the control of nutrients and toxic materials during construction activities in the Galveston Bay watershed. The remaining implementation steps on this Action are the same as steps 3 - 6 on Action NPS-12, with the focus in this case on the control of toxics and nutrients during construction. If CZM is not implemented, then the Galveston Bay Program and the HGAC will work with local municipalities to implement some or all of the measures in the CZM guidance that are practical here:

- Properly store, handle, apply, and dispose of pesticides
- Properly store, handle, apply, and dispose of petroleum products
- Establish fuel and vehicle maintenance staging areas away from drainage courses
- Provide sanitary facilities for construction workers
- Store, cover, and isolate construction materials
- Develop and implement a spill prevention and control plan
- Maintain and wash equipment and machinery in confined areas to control runoff
- Develop and implement nutrient management plans
- Provide adequate disposal facilities for solid waste, including asphalt
- Educate construction workers about proper materials handling and spill response procedures

When



Where All of local Galveston Bay watershed.

Who Lead entities: HGAC, TNRCC, local municpalities, and Galveston Bay Program. Other participants: GLO, EPA, local developers and construction companies, and Houston/Harris County Joint Storm Water Management Task Force. Role of Galveston Bay Program: Conduct Action.

Public Costs of New Actions (5 years)

• Program	$ 7,500
TOTAL	$ 7,500

Private Costs: moderate costs to developers, contractors. Potential Funding Sources: USDA, NOAA, EPA, TWDB.

Regulatory Issues No new regulatory authority needed under existing NPDES permits (including Houston/Pasadena/unincorporated areas of Harris County). Other municipalities need to adopt ordinances to implement these measures at construction sites. At county level, however, adoption of construction practice regulation is problematic, since no ordinance-making powers exist at the county level. Regulation would have to occur based on local ordinance-making powers.

Related Actions: NPS-1, NPS-2, NPS-3, NPS-12, WSQ-1, WSQ-2, WSQ-3, WSQ-4, WSQ-5, WSQ-6, WSQ-7, PPE-8, PH-1.

ACTION NPS-14:

Require Sewage Pumpout, Storage, and Provisions for Treatment

What Require sewage pumpout, storage, and provisions for treatment for all marinas greater than 10 boat slips in Galveston Bay waters. Achieve zero sewage discharge from marinas by linking enforcement to marina construction and designate, though state or federal authority, key areas (such as Clear Lake) as no discharge zones. Note that this action is primarily directed at recreational boating, as commercial vessels are already regulated by the Coast Guard.

How

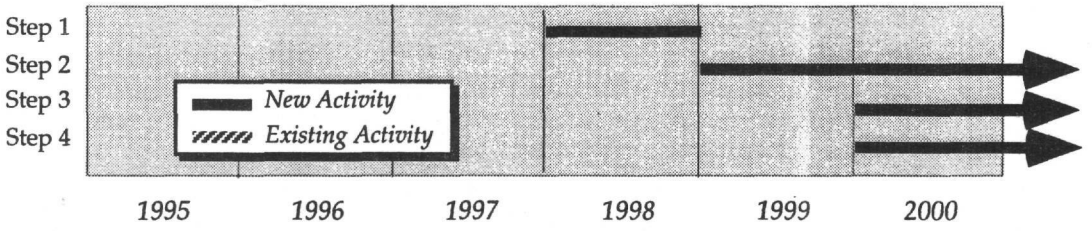
Step 1 GLO will require, via its permits, that marinas with capacity for long-term anchorage of more than 10 vessels shall provide pump-out facilities for marine toilets, or other such measures that provide an equal or better level of water quality protection.

Step 2 Galveston Bay Program will work with other agencies and private organizations to establish an educational effort for marina users and to provide technical assistance to marinas to comply with the new state requirements.

Step 3 TNRCC will designate sensitive areas of Galveston Bay as no-discharge zones.

Step 4 TPWD will manage new boat registrations and the GLO will limit permits for marina construction in the vicinity of no-discharge zones based on evidence that violations of boat/marina sewage management requirements are still occurring.

When



Where All marinas in sensitive areas of Galveston Bay and tributary waters that are impacted by discharge of marine sewage.

Who Lead entity: GLO, TPWD, and TNRCC. Other participants: Galveston Bay Program, local marinas, and local municipalities. Role of Galveston Bay Program: Coordination.

Public Costs of New Actions (5 years)

• Program	$ 30,000	• TPWD	$ 28,750
• GLO	$ 42,500		
TOTAL			**$ 101,250**

Private Costs: Potentially high to marina and boat owners. Potential Sources of Funding: USDA, NOAA, EPA, and TPWD.

Regulatory Issues May need new local or state regulations to implement, or can be accomplished via CMP consistency.

Related Actions: NPS-15, NPS-16, PPE-8, PH-2, and PH-3.

ACTION NPS-15:
Require Use of Marine Sanitary Chemicals That Can Be Treated in POTWs

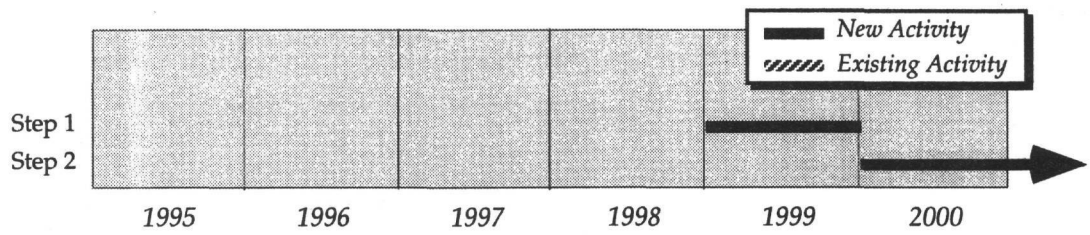
What Restrict use of marine sanitary chemicals to those that are compatible with the wastewater treatment plant processes.

How

Step 1 TNRCC will adopt rules to ban marine sanitary chemicals that are incompatible with wastewater treatment plant processes. Implementation of this Action also will depend on the educational efforts to be implemented under Action NPS-14, with the focus in this case on sewage-management alternatives for boaters and marinas.

Step 2 Galveston Bay Program will work with other agencies to promote marina demonstration projects which illustrate alternatives for effective sewage management.

When



Where All marinas on Galveston Bay and tributary waters to the bay.

Who Lead entity: TNRCC. Other participants: Galveston Bay Program, GLO, local boat supply retailers, and boat owners. Role of Galveston Bay Program: Coordinating.

Public Costs of New Actions (5 years)

• Program	$ 7,500	• GLO	$ 7,500
• TNRCC	$ 90,750		
TOTAL			**$ 105,750**

Private Costs: Overall low cost to boat owners. Potential Sources of Funding: NOAA, and EPA.

Regulatory Issues Will need new local or state regulations to implement product bans.

Related Actions: NPS-15, NPS-16, PPE-8, and PH-1.

ACTION NPS-16:
Implement Washdown Controls and Containment Measures

What Implement washdown controls and containment requirements for all marinas (i.e., all marinas greater than 10 boat slips with a SIC code of 4493: marinas where vehicle (boat) rehabilitation, mechanical repairs, painting, fueling, and lubrication or equipment cleaning operations are conducted).

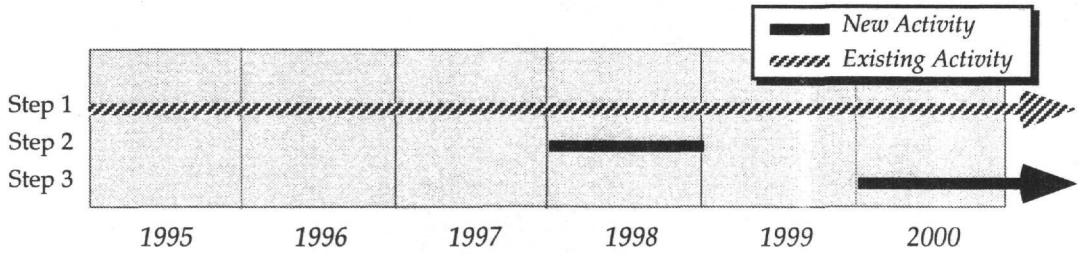
How

Step 1 Marinas covered by the federal storm water permit program (if any) will continue to implement required pollution prevention measures.

Step 2 GLO will adopt rules based on the Texas Coastal NPS Reduction Plan (Action NPS-6) to establish pollution prevention requirements for marinas, marine gas stations and related activities in the Galveston Bay vicinity.

Step 3 Galveston Bay Program will incorporate marina and boating Best Management Practices into the *Galveston Bay BMP Performance Document* to be prepared under Action NPS-2. Implementation of this Action also will depend on the educational efforts to be implemented under Action NPS-14

When



Where All marinas on Galveston Bay and tributary waters to the bay.

Who Lead entities: Marina owners with NPDES permits. Other participants: Local municipalities, TNRCC, GLO, Coast Guard, and EPA. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 24,000
• TNRCC	$ 63,000
TOTAL	**$ 87,000**

Private Costs: moderate to high for marina owners. Potential Sources of Funding: NOAA and EPA.

Regulatory Issues May need new local or state regulations to implement and enforce.

Related Actions: NPS-14, NPS-16, WSQ-1, WSQ-2, WSQ-3 WSQ-4, and PPE-8.

Point Sources of Pollution

The Galveston Bay Plan
Galveston Bay National Estuary Program

OVERVIEW OF THE ACTIONS

THE ISSUES

The impacts of point source discharges on water and sediment quality in Galveston Bay have been studied for many years. Point source discharges originate from municipal and industrial facilities, bypasses and overflows from municipal sewage systems, unpermitted and illegal discharges, and produced water from oil and gas operations. In the past, discharges of pollutants from municipal and industrial wastewater treatment plants have upset the healthy balance of marine life in portions of the Galveston Bay estuary system. However, since the 1970's, the pollutant loadings from large municipal and industrial discharges have been closely regulated through several management actions established under federal and state water pollution control laws. The permitting process established under these laws has been successful in reducing the concentration of pollutants entering the Galveston Bay system from these sources. Federal and state permitting rules also regulate the discharge of produced water from oil and gas operations and some progress is being made in reducing the concentration of pollutants entering the bay from these activities.

This action plan focuses on improving the control of toxicants, nutrients, and other pollutants discharged into the Galveston Bay system from sewage bypasses and overflows, illegal connections to storm sewers, and oil and gas field operations. Sewage bypasses and overflows occur during periods of heavy rainfall when the capacity of the sewer system to manage the

wastewater flow is exceeded and untreated sewage flows directly into the bay. The high concentrations of fecal coliform bacteria, nutrients, and suspended solids in the untreated wastewater can adversely affect aquatic life in the bay and cause areas of the bay to become unsafe for contact recreation activities such as swimming. Illegal storm sewer connections also result in the introduction of untreated wastes directly into bay tributaries. Oil and gas produced water discharges can also have deleterious effects on water quality and aquatic life in the bay as the brine contains high concentrations of salts and hydrocarbons. *The Galveston Bay Plan* recommends the following initiatives for remedying environmental problems in the bay area related to point sources of pollution:

- Sewage Bypass and Overflow Elimination: Two actions are proposed to address the problem of untreated wastes entering the Galveston Bay system from sewage bypasses and overflows during storm events. Studies are needed to identify sewage bypass or overflow problems in wastewater collection systems. *The Plan* also supports the efforts of the Texas Natural Resource Conservation Commission (TNRCC) to issue administrative orders to publicly owned treatment works (POTWs) requiring the POTWs to improve their sewage systems by increasing collection and storage capacity, and eliminating infiltration into the sewage systems.

- Small Wastewater Treatment Plant Operations Improvement: *The Galveston Bay Plan* offers two actions for improving operations at small wastewater treatment plants. The Gulf Coast Waste Disposal Authority (GCWDA) and other agencies will identify small wastewater treatment plants within the Galveston Bay watershed that may be adversely impacting water quality. These will also evaluate potential management options for more effective oversight of these small systems including consolidation of these small treatment plants into larger regional systems and providing improved compliance monitoring and enforcement.

- Elimination of Illegal Storm Sewer Connections: An action is presented to initiate a dry-weather illicit connection program in segments of the Galveston Bay tributaries that exhibit water quality problems. Accidental and intentional connections of sanitary sewage lines to storm sewers causes elevated concentrations in fecal coliform bacteria. Municipalities and POTWs will be encouraged by this action to implement voluntary detection programs for illicit connections to their storm sewer systems.

- Produced Water Management: *The Plan* supports the efforts of the U.S. Environmental Protection Agency (EPA) and the Texas Railroad Commission (RRC) to eliminate significant harm from produced water discharges by issuance of NPDES general permit or by implementation of a Texas Railroad Commission program. This action will protect plant and animal life in tidal areas from the toxic lethal and sublethal impacts of hydrocarbons and salts.

ENVIRONMENTAL STATUS

Status and Trends

Industrial and Municipal Discharges to the Houston Ship Channel

In the 1960s and early 1970s point source pollution from industrial and municipal discharges had virtually wiped out all aquatic life in the Houston Ship Channel above the confluence of the San Jacinto River and was identified by some as a potential threat to the health of the entire Galveston Bay system. The annual Biochemical Oxygen Demand (BOD, a measure of the amount of oxygen-robbing pollutants in water) pollutant loading increased after the turn of the century, because 1) rapid municipal and industrial growth increased the amount of raw wastewater being generated, and 2) most of the wastewater was being discharged with inadequate treatment or no treatment at all. The increase in loadings over time is shown in the following figure.

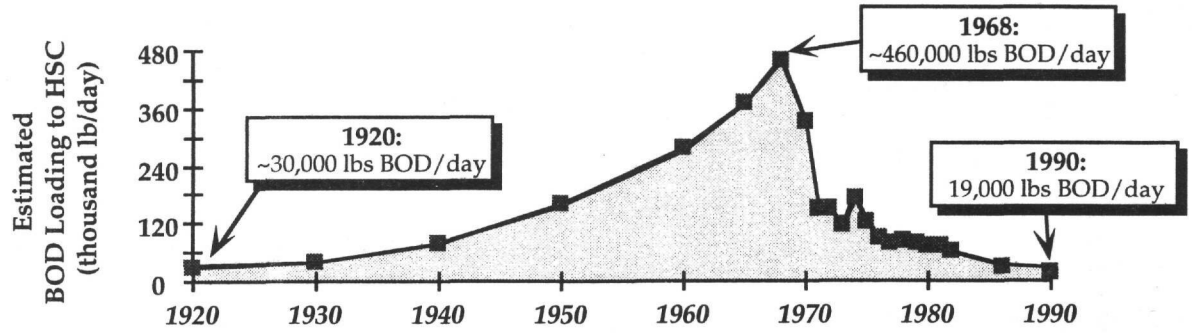


FIGURE PS-1. Changes Over Time in the Biochemical Oxygen Demand (BOD) Loadings to the Upper Houston Ship Channel (HSC) from Municipal and Industrial Point Sources

The Federal Water Quality Act of 1965 required each state to develop water quality standards for all navigable waters in their jurisdictions by 1967. To comply with this mandate, the Texas Water Quality Board divided the state into 23 basins with several zones per basin and developed standards based on the desired water use. For example, West Bay was designated for recreational swimming while the Houston Ship Channel was designated commercial-industrial. The Ship Channel was to be of "an aesthetically acceptable quality, that it be aerobic, and that the main portion of it be suitable for non-contact recreation."

The state embarked on a low-profile approach to reducing wastewater pollutant loads to the channel, and in 1968 began reducing permitted BOD loads for some dischargers. Operation Clean Sweep was initiated in late 1968 to evaluate the compliance of every discharger in the state. Primarily because of the state-led reductions from industrial permit holders, the total BOD loads to the channel declined from approximately 460,000 pounds per day in 1968 to 152,000 pounds per day in 1971.

Despite these reductions, there were still tremendous water quality problems in the Houston Ship Channel in the early 1970s. The upper sixteen miles of the Channel still did not support any aquatic life, and the pollutants discharged to the channel were associated with massive

fish kills in the upper part of Galveston Bay. The lack of visible progress resulted in a federal attempt at intervention, as summarized below from information in a 1972 Conservation Foundation publication "The Decline of Galveston Bay" by James Noel Smith.

Federal Shellfish Conferences

According to the 1972 Water Quality Act, the newly-formed U.S. Environmental Protection Agency (EPA) could only intervene for water quality reasons in three ways. The first two approaches, a federal lawsuit and a standard-enforcement conference, required the consent of the governor. Because the governor of Texas was not likely to concur, the third avenue – a federal shellfish conference – was used. Shellfish were tied into interstate commerce, and therefore were indirectly included as part of EPA's regulatory authority. The EPA had to prove that shellfish industry had suffered substantial economic harm from pollution in order to force water quality improvements in state waters.

The first Shellfish Conference, held on June 7, 1971, in Houston's Rice Hotel, resulted in a somewhat confrontational discussion between state and federal officials regarding the status of the oyster harvest and the progress towards reaching water quality goals for the Ship Channel and the bay. Despite the acrimony at the first conference, the state and EPA embarked on a joint program to evaluate water pollution problems in the bay. A second Shellfish Conference was convened in November 1971 and was conducted in a much less confrontational manner than the first conference held five months before. Eleven specific cleanup actions were agreed on by the state and federal conferees including several recommendations on sampling and research needs. It was agreed, for example, to begin dechlorination of all sewage discharges, and that waste load allocations for the entire bay would be performed by June 1972.

Most importantly, the conferees also agreed to limit BOD discharges to the Houston Ship Channel to 35,000 pounds per day, a drastic reduction from the state's permitted limit of 180,000 pounds per day. The scientific basis of the 35,000 pound per day limit was a "back of an envelope" calculation performed by Art Busch, a professor at Rice University and future Regional Director of EPA. He estimated that 35,000 pounds of BOD per day was the maximum load that would still result in dissolved oxygen concentrations of 1 milligram per liter, making the upper part of the Ship Channel aerobic.

Era of Point Source Reductions

The new BOD limit was a dramatic change in overall policy towards water quality in the Ship Channel and Galveston Bay. The Texas Water Quality Board estimated that *The Plan* would cost $800 million and would require 20 years to complete the required improvements to existing treatment plants and build new plants. Nevertheless, new discharge limits were issued, and industrial and municipal discharges began reducing their pollutant loadings. By 1990 less than 19,000 pounds per day of BOD were discharged into the Houston Ship Channel by municipal and industrial dischargers, less than the estimated discharge in the 1920s (see Figure PS-1).

Although there are still problems, these management actions in the 1970s resulted in a dramatic improvement in the Houston Ship Channel. There has been an increasing trend in dissolved oxygen concentrations with recent Texas Water Commission (TWC) sampling of the

upper channel and turning basin (Segment 1007) showing an average concentration of 3.2 milligram per liter. There is now "extensive" utilization of the channel by a variety of organisms. The lower channel supports a healthy and viable fish population year-round. In winter months, the upper channel has a species richness and abundance that exceeds the lower channel, and maintains a viable shoreline assemblage during the summer months. Although the Houston Ship Channel currently possesses a "no aquatic life" designation, the increased utilization by fish, shrimp, and crab may have implications on the future use designations of the channel.

Current Point Source Loadings

An estimate of the total contribution of various water quality pollutants from point sources (both municipal and industrial), local watershed non-point sources, the San Jacinto River, and the Trinity River was developed using information from a series of GBNEP reports. The preliminary analysis indicates that municipal and industrial point discharges are no longer the primary source of most pollutants to Galveston Bay:

	Percentage of Annual Pollutant Loading to:			
	Entire Galveston Bay System		**Houston Ship Channel**	
Parameter	***From Municipal Point Sources***	***From Industrial Point Sources***	***From Municipal Point Sources***	***From Industrial Point Sources***
Flow	3 %	1 %	22 %	5 %
BOD	3	7	7	16
Total Suspended Solids	<1	1	1	3
Total Phosphorous	30	4	79	10
Total Nitrogen	37	7	64	11
Oil and Grease	28	3	38	4
Total Cadmium	20	3	68	9
Total Copper	7	3	41	20

Probable Causes

Bypasses and Overflows

During heavy rains large quantities of groundwater and/or stormwater may enter the wastewater collection system through manholes, broken or defective lines, and other openings in the collection system, greatly increasing the flow in the collection lines. These excess flows may cause the capacity of the collection system and/or treatment plant to be exceeded. Raw or partially treated sewage can be discharged into Galveston Bay waters through these bypasses or overflows from municipal wastewater collection systems. Wastewater collection systems were not designed to convey storm water, which is intended to be conveyed in storm drains or via surface drainage in the streets. During rains, water enters the collection system through cracks in pipes (public and private) and manhole leaks that have developed over the years from soil settlement, corrosion of concrete pipe, and in some cases, poor construction practices. Sufficient rainwater can enter the collection system to cause an overload, resulting

in overflows of diluted sewage from manholes or overflow structures specifically installed to provide system relief.

A 1986 study estimated the relative contribution of different wet-weather pollutant sources to the Houston Ship Channel by collecting over 500 samples of storm data from numerous streams, land use areas, wastewater treatment plants, and other parts of the collection system. This effort indicated that the total BOD loading from bypasses and overflows to the Houston Ship Channel was 3.1 million kilograms per year (equivalent to an average value of 18,900 pounds per day). By comparing all of the loading sources (including non-point sources), the authors concluded that bypasses and overflows contributed approximately 11 percent of the annual BOD load, seven percent of the annual TSS load, and seven percent of the annual ammonia load to the Ship Channel in 1986.

In response to an EPA initiative, the City of Houston is now undertaking a $1.2 billion construction project to improve and expand the city's underground wastewater collection system. A series of deep tunnels are being constructed in combination with rehabilitation of existing lines, construction of relief lines, etc. to control bypasses and overflows for the 2-5 year frequency storm, that is all but the largest rainfall events. So far this program has resulted in complete elimination of dry-weather overflows, and a 60-90 percent reduction in the volume of wet weather overflows.

Unpermitted and Illegal Discharges

Because improvements in the point source discharges and the collection system did not improve dry-weather water quality in the Buffalo Bayou watershed, a special survey of illegal (illicit) discharges to the storm drainage system was conducted by the City of Houston. This survey indicated that accidental and intentional connections of sanitary sewage lines to the storm sewers was responsible for elevated concentrations of fecal coliforms to Buffalo Bayou. By eliminating these discharges, there was a marked improvement in dry-weather water quality.

Along the bay shoreline, however, illegal discharges did not appear to be as prevalent. As part of a GBNEP study, a detailed visual search was conducted for discharge pipes in nine shoreline segments around Galveston Bay: Cedar Bayou, Galveston Bay, Double Bayou, East Bay, Chocolate Bayou, Armand Bayou, Dickinson Bayou, Carancahua Bayou and Carancahua Lake. The authors identified a total of 69 permitted discharges and 117 "unpermitted" discharge pipes along the shoreline in these segments. Most of these pipes were storm drains, dredge material disposal, oil field related, lawn drainage, or apparent sewage discharges. A subsequent evaluation of some of these unpermitted discharges by the Texas Natural Resource Conservation Commission (TNRCC) concluded that there appeared to be no illegal sanitary sewer connections or illegal point source discharges along the shoreline, however. The Texas Railroad Commission investigation of 17 discharges identified as oil field related showed that 12 were actually related to oil field operations. Of these, seven were permitted and five did not require a permit; however three violation letters were issued.

Regionalization of Small Municipal Treatment Systems

Lack of coordination, insufficient use of new technologies, and inadequacies within existing systems enables excessive quantities of pollutants to enter Galveston Bay via approved discharge networks. Individual utility districts, industries, and municipalities operate separate wastewater treatment systems, resulting in lost efficiency, consistency, and economies of scale. These problems are mainly focused in the unincorporated portions of the counties around Galveston Bay.

Oil and Gas Production

In the process of recovering oil and gas, or produced water is also withdrawn from underground formations. Á common method of produced water disposal along the Texas coast is discharge to surface waters, either directly or by overland flow. Substantial negative impacts have been documented from such discharges, and are especially acute where large discharges occur in low energy and nearshore environments. Some observed effects are:

- Formation of density gradients (circulation of dense produced water) in low-energy systems such as bayous
- Incorporation of oil and chloride into sediments near discharges, severely depressing the abundance and richness of benthic (bottom-dwelling) organisms
- Elevation of salinities which inhibit aquatic life
- Ingestion and incorporation of petroleum hydrocarbons into the tissues of various aquatic organisms
- Toxic lethal and sublethal impacts to plant and animal life

Texas Railroad Commission (RRC) data indicates that some 93 discharges were permitted in 1991 to release up to 15.2 million gallons of produced water per day to Galveston Bay and its tributaries. Of these, some 62 discharges were active in early 1993, for an estimate of 5.8 million gallons per day actual discharge into the Galveston Bay system. Of this amount, however, approximately 3.4 million gallons per day were from one source, which voluntarily began deep-well injection in early 1993. Actual discharges into the bay vary greatly, depending upon the economic feasibility of oil production and the length of reservoir production (i.e., older fields yield proportionally more water).

MANAGEMENT STATUS

Regulatory Basis

Generators of point source discharges are regulated under a dual permitting system. They must obtain permits both from the TNRCC or from the RRC for oil and gas activities and from the EPA. The statutory and regulatory framework for reducing point source pollution is generally strong and consistent with the two decades of experience in implementing the program.

Because of increased public interest in toxic substances, the TWC substantially revised water quality standards in 1987 to include numerical criteria for several toxic substances and

required whole effluent toxicity testing by most point source dischargers. In 1991 the TWC again revised the standards to regulate 30 toxics affecting aquatic life and 66 affecting human health either through drinking water or contaminated fish and shellfish; these criteria are imposed depending on the designated use of the segment. Most observers are convinced that implementation of these standards will continue to reduce the amount of these substances discharged to water.

The standards are revised periodically. Some of the current issues TNRCC will be addressing are:

- Minimum presumptions for unclassified waters
- Procedures for site-specific standards revisions
- Wetlands standards
- Outstanding natural resource waters
- Toxic criteria to protect aquatic life
- Toxic criteria to protect human health
- Salinity
- Endangered species
- Site-specific standards

The RRC regulates all oil and gas exploration and production activities in the state through regulatory and permitting requirements. Because the RRC has not received federal authorization from the EPA for its oil and gas discharge permitting program, permits are required from both agencies for wastewater discharges. The RRC issues tidal disposal permits in accordance with the applicable surface water quality standards (less than 25 milligram per liter of oil and grease). The RRC prohibits produced water discharges into freshwater but still permits these discharges into tidal reaches. A recently proposed National Pollutant Discharge Elimination System (NPDES) general permit for produced water and sand discharges to coastal waters in Louisiana and Texas would ban tidal discharges in favor of reinjection.

Management Problems

Although TNRCC's resources for permitting seem adequate, an over-emphasis on facilities consistently in compliance reduces resources for enforcement of smaller systems. Most compliance problems seem to be generally associated with smaller dischargers rather than the large high-volume industrial and municipal dischargers. These problems are likely to increase as state resources committed to compliance are being reduced due to other federal mandates, and local agencies cannot fill this gap due to conflict-of-interest issues.

Data gaps in point source monitoring programs have made it difficult to accurately quantify some pollutant loads from point sources. Bay-wide loading estimates for nutrients are incomplete for two reasons: 1) nutrient concentrations are not reported by all dischargers, and 2) chemical forms analyzed in tributaries are inconsistent between many NPDES dischargers and those measured by the U.S. Geological Survey (USGS) in tributaries. Loading estimates for metals are incomplete because they are not reported by all dischargers and because the chemical forms (mainly total recoverable versus dissolved forms) analyzed are inconsistent

between dischargers and USGS data. Loading estimates for complex organics are the most incomplete of all those reported because of the great inconsistency of reporting among dischargers.

POINT SOURCES OF POLLUTION ACTION PLAN

To improve the control of toxicants, nutrients, and other pollutants discharged into the Galveston Bay system by industrial, municipal, and petroleum dischargers, reducing and eventually eliminating harm from such contaminants entering or accumulating in the Galveston Bay ecosystem.

OVERVIEW

Priority Problem:

Raw or partially treated sewage enters Galveston Bay from Publicly Owned Treatment Systems (POTWs) due to design and operational problems, especially during rainfall runoff. These discharges contribute to eutrophication, bacterial contamination, shellfish harvest closures, and other water quality problems. A 1986 study indicated that bypasses and overflows contributed approximately eleven percent of the annual BOD load, seven percent of the annual TSS load, and seven percent of the annual ammonia load to the Ship Channel. Although the City of Houston has undertaken a 1.2 billion-dollar project to correct their problems, many smaller municipalities still have serious overflow and bypass problems that reduce the quality of Galveston Bay water. Texas City, for example, is now starting a $23 million program to address bypass and overflow problems in the Texas City area.

Goal:

Eliminate wet weather sewage bypasses/overflows. To meet this goal, the wastewater collection piping associated with many of the area's wastewater systems will have to be improved, expanded, or reconstructed. The City of Houston is currently rehabilitating existing lines and constructing relief lines and wet-weather primary treatment facilities to expand the capacity of their collection system and is trying to eliminate sources of wet-weather infiltration.

Objective:

By 2004, develop sufficient overflow and bypass capacity to control a storm of up to five-year frequency. (The TNRCC, EPA, and the City of Houston are working to determine the critical storm frequency with no significant impact on water quality, with two-year and five-year being the leading candidates).

Action PS-1: Determine location and extent of bypass and overflow problems.
Action PS-2: Eliminate or reduce bypass and overflow problems.

Goal:

Eliminate pollution problems from poorly operated small wastewater treatment plants. Some urban and suburban areas of the watershed are served by numerous small "package plants," many of which do not receive adequate maintenance to meet current discharge standards. Regionalization would consolidate the numerous smaller plants into a small number of larger better operated, wastewater treatment plants.

Objective:

By 2004, ensure that all wastewater treatment plants operate in accordance with permit requirements, including consolidation of small plants where feasible.

Action PS-3: Regionalize small wastewater treatment systems.
Action PS-4: Improve compliance monitoring/enforcement for small discharges.

Priority Problem:

Illegal connections to storm sewers introduce untreated wastes directly into bay tributaries. A study performed by the City of Houston indicated that illegal discharges to the storm sewer system (both inadvertent and intentional) had a significant effect on dry-weather fecal coliform concentrations in Buffalo Bayou.

Goal:

Eliminate illegal connections to storm sewers, which result in introduction of untreated wastes directly into bay tributaries. By eliminating these discharges, the dry-weather concentrations of fecal coliforms in the urbanized stream segments can be reduced and these segments made safer for contact recreation.

Objective:

By 1997, eliminate all identified illicit connections to storm sewers.

Action PS-5: Implement a dry-weather illegal connection program.

Priority Problem:

Certain toxic substances from produced water discharges related to oil production have contaminated sediment and may have a negative effect on aquatic life in contaminated areas. The Railroad Commission permits the discharge of oil field produced water directly into tidal waters and there are approximately 60 of these permitted produced water discharges in the Galveston Bay system. Several water quality and biologic studies have determined that produced water discharges can create oil sheens, clog and contaminate sediments with oil and grease, elevate and chemically alter salinity, introduce low-level radioactive compounds, and result in toxic lethal and sublethal impacts to benthic organisms at substantial distances from the discharge point. EPA does not yet permit coastal produced waters under the mandated NPDES permits.

Goal:

Eliminate harm from produced water discharges. The first approach is to have EPA issue a final NPDES Coastal General Permit. If this final permit is the same as the December 12, 1992 proposed

ACTION PS-1:
Determine Location and Extent of Bypass and Overflow Problems

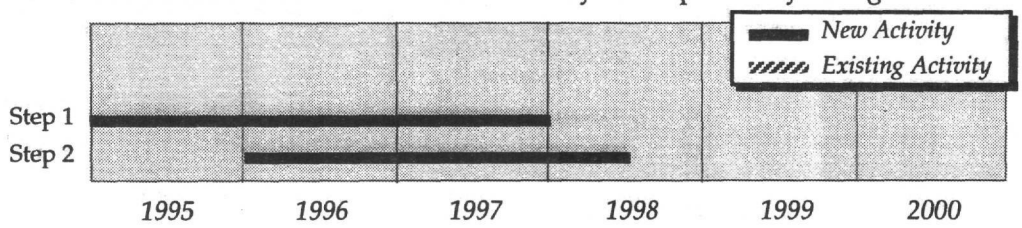
What Conduct a study to identify collection systems in Publicly Owned Treatment Works (POTWs) with bypass or overflow problems.

How

Step 1 The TNRCC and EPA will require all wastewater discharge permit holders for POTWs to conduct studies of their collection and treatment systems to identify and evaluate any bypass or overflow problems. If necessary, the TNRCC will issue administrative orders requiring dischargers to conduct the necessary studies. These studies will include a review of records, existing water quality data, and a hydraulic analysis. Studies for large POTWs must be completed during 1996 so that any corrective action plans may be completed by mid-1997. Studies for small POTWs must be completed during 1997 so that any corrective action plans may be completed by mid-1998. (The City of Houston is already implementing a comprehensive bypass/overflow elimination program.)

Step 2 Permit holders for large POTWs will develop corrective action plans to address bypass and overflow problems by mid-1997 for submission to TNRCC. Permit holders for small POTWs must develop their plans by mid-1998. TNRCC will issue administrative orders as needed to require plan preparation. Some research may be needed to 1) determine the costs and environmental benefits associated with different levels of control (what return frequency to design controls for) and 2) determine if elimination of these pollutant sources will allow inshore areas of Galveston Bay to be open for oystering.

When



Where All municipalities and other governmental entities operating wastewater treatment plants in local Galveston Bay watershed (below Lake Houston and Lake Livingston) that are not currently undertaking a bypass/overflow control program. Note that Galveston is currently under an order to do so.

Who Lead entities: TNRCC, EPA, and local municipalities. Other participants: MUDs, GCWDA, TWDB, GLO, Galveston County, Harris County, Chambers County, Brazoria County, and Liberty County. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 37,500
TOTAL	$ 37,500

Private Costs: Low. Actions Tied to Other Programs: Existing costs are for on-going City of Houston program (see text); proposed costs are estimated by applying similar program to all other municipalities in watershed. The existing costs have already been committed by the City of Houston, while the proposed costs will probably be mandated by EPA with or without *The Galveston Bay Plan*. Potential Sources of Funding: NOAA, EPA, and TWDB.

Regulatory Issues EPA and TNRCC will need to issue administrative orders as needed.

Related Actions: PS-2, WSQ-6, WSQ-7, PH-2, PH-3, and NPS-3.

ACTION PS-2:
Eliminate or Reduce Bypass and Overflow Problems

What Publicly Owned Treatment Works (POTWs) will design and build improvements to collection systems and treatment plants to eliminate or reduce bypass and overflow problems. This includes but is not limited to 1) increasing the capacity of the collection system, 2) eliminating infiltration sources, and 3) increasing storage capacity. Note that this action will be directed at POTWs outside of the City of Houston, as Houston is currently undertaking a 1.2 billion dollar project to reduce bypass and overflow problems.

How

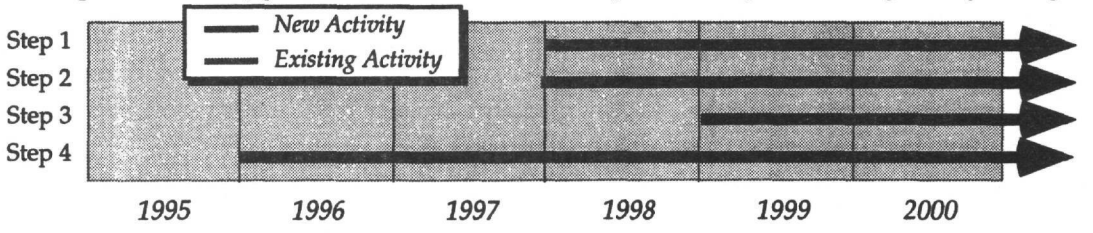
Step 1 The TNRCC and EPA will issue administrative orders to wastewater discharge permit holders for POTWs to require implementation of their corrective actions plans to address bypass and overflow problems.

Step 2 Permit holders for large POTWs will begin implementing their corrective action plans in Fiscal Year 1998 according to a schedule negotiated individually with TNRCC.

Step 3 Permit holders for small POTWs will begin implementing their corrective action plans in Fiscal Year 1998 according to a schedule negotiated individually with TNRCC.

Step 4 TNRCC and the EPA will monitor progress and review their existing regulations regarding POTW operations and penalties for bypasses/overflows and will implement any needed regulatory changes.

When



Where All municipalities and other governmental entities in local Galveston Bay watershed with bypass or overflow problems. The City of Houston has an extensive on-going program to deal with overflow and bypass problems.

Who Lead entities: TNRCC, EPA and local municipalities. Other participants: MUDs, GCWDA, and GLO. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 11,250
TOTAL	$ 11,250

Private Costs: Low. Actions Tied to Other Programs: Existing costs are for on-going City of Houston program (see text); proposed costs are estimated by applying similar program to all other municipalities in watershed. The existing costs have already been committed by the City of Houston, while the proposed costs will probably be mandated by EPA with or without *The Galveston Bay Plan*. Potential Sources of Funding: USDA, NOAA, EPA, and TWDB.

Regulatory Issues EPA and the TNRCC will need to issue administrative orders to implement this action.

Related Actions: PS-1, WSQ-6, WSQ-7, PH-2, PH-3, and NPS-3.

ACTION PS-3:
Regionalize Small Wastewater Treatment Systems

What Consolidate small treatment systems into larger regional systems so that it will be easier to properly operate and monitor the performance of point source dischargers.

How

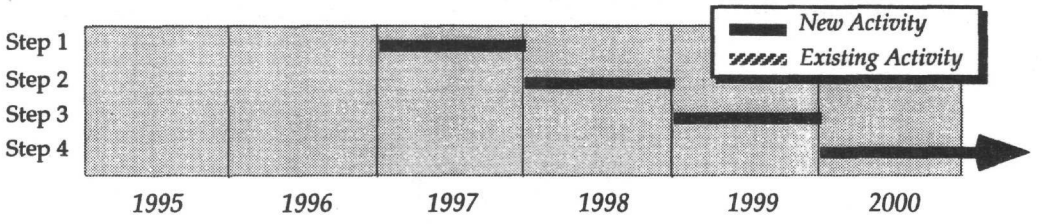
Step 1 The Gulf Coast Waste Disposal Authority (GCWDA) will lead an interagency effort to identify all small wastewater treatment plants in the Galveston Bay watershed. The Galveston Bay Program and GCWDA recognizes that many technical aspects need to be addressed regarding the scope, organization, project management, and implementation of such an effort.

Step 2 GCWDA will lead an interagency effort to evaluate the permit compliance record of small wastewater treatment plants identified in the bay watershed and evaluate adverse impacts on water quality of permit violations.

Step 3 GCWDA will lead an interagency effort in coordination with the City of Houston Regionalization Plan to identify potential management options for more effective oversight of small treatment systems. These options could include a variety of operators and approaches. (One option for consideration is to require under all new permits for small systems that a fee be paid or a bond posted prior to construction to ensure that funds are available for ongoing system maintenance and operation. These funds also might be earmarked for potential future regionalization costs.)

Step 4 Based on the results of previous steps, GCWDA will lead an interagency effort to develop proposals to the TNRCC for specific treatment system consolidations and/or system management consolidations. Consolidation plans will be implemented following TNRCC approval. TNRCC and GCWDA will monitor the effectiveness of the consolidation actions.

When



Where Areas served by small treatment systems that cause in-stream water quality problems. Example areas might be parts of Ft. Bend County, Cypress Creek area, and other suburban areas served by a number of small MUDs.

Who Lead entity: GCWDA and TNRCC. Other participants: Local municipalities, MUDs, GLO, and USGS. Role of Galveston Bay Program: Coordinating.

Public Costs of New Actions (5 years)

• Program	$ 11,250
• GCWDA	$ 315,000
TOTAL	$ 326,250

Private Costs: Low. Ultimate public Costs: Potentially very high to fund required construction projects. Potential Sources of Funding: USDA, HUD, USGS, EPA, and TWDB.

Regulatory Issues May require local and state legislation to give GCWDA the authority to implement regional treatment if GCWDA is identified as the preferred operator. A possible approach to encouraging regionalization is to require that new permit holders with small systems pay a fee or post a bond prior to construction to ensure that funds are available for system maintenance and operation, or to ensure funding for potential future regionalization effort. Consistency review of any federal assistance to these small systems can be used as a tool to encourage regionalization.

Related Actions: PS-1, WSQ-6, and NPS-3.

ACTION PS-4:
Improve Compliance Monitoring and Enforcement for Small Dischargers

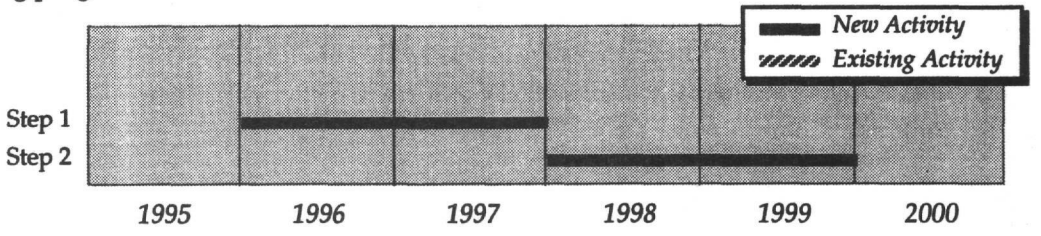
What Improve compliance monitoring and enforcement of small permitted wastewater dischargers to 1) ensure that current reporting system is functioning as planned, 2) identify violators of permit requirements, 3) determine which plants are operating adequately and which plants have operational problems.

How

Step 1 The EPA and the TNRCC will jointly conduct internal evaluations of their existing compliance monitoring and enforcement programs and develop recommendations for improvement. Priorities for this evaluation are to ensure reliable reporting by permitted dischargers and effective identification of permit violations and problem plants. Items for consideration include 1) increased agency commitment and funding for these programs, and 2) stronger focus on smaller treatment systems because they now represent a bigger compliance problem than well-funded and established larger dischargers. Other potential activities include 1) support transfer of NPDES authority to the TNRCC, develop a map of NPDES discharge points for TNRCC/EPA enforcement personnel, 2) establish a synchronous schedule for permit expirations on a watershed and subwatershed basis (subwatersheds such as Brays Bayou, Sims Bayou, Clear Creek, Dickinson Bayou etc.), and 3) expand pretreatment requirements to include small plants which receive industrial wastes.

Step 2 EPA and TNRCC will implement improvements to their compliance monitoring and enforcement programs (including potential new funding requests based on internal evaluations). Where appropriate, TNRCC will utilize county compliance monitoring data to augment existing TNRCC compliance monitoring programs.

When



Where Small permitted wastewater treatment systems in the Galveston Bay watershed.

Who Lead entity: TNRCC and EPA. Other participants: EPA, GCWDA, POTW operators, and USGS. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• Program	$ 68,500
• TNRCC	$ 75,000
TOTAL	$ 143,500

Private Costs: Potentially high for small private discharges because of increased monitoring and operational costs. Potential Sources of Funding: EPA, TWDB.

Regulatory Issues May require additional funding from state or the collection of inspection fees.

Related Actions: WSQ-4, WSQ-5, and WSQ-7.

ACTION PS-5:
Implement a Dry-Weather Illegal Connection Program

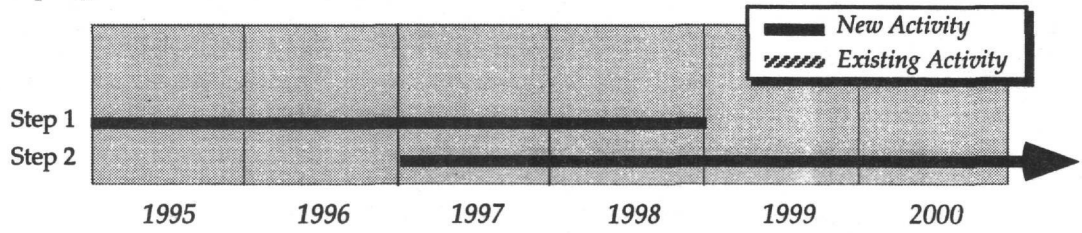
What Initiate a dry-weather illicit connection program by 1997 in segments draining into Galveston Bay that exhibit water quality problems.

How

Step 1 The TNRCC will lead in encouraging municipalities and permit holders for Publicly-Owned Treatment Works (POTWs) to implement voluntarily detection programs for dry-weather illicit connections to their storm sewer systems. Based on results from Houston's program, breaks in the wastewater collection piping has been responsible for over 90 percent of the problem. Improper tie-ins (typically plumbing mistakes) constitute less than 10 percent of the problems.

Step 2 TNRCC will determine whether detection programs should be made mandatory for municipalities under its implementing rules for the state Municipal Water Pollution Control and Abatement Program. The Galveston Bay Program will use ambient monitoring data to determine the effectiveness of dry-weather connection programs.

When



Where Example streams subject to this program with storm sewers that drain heavily urbanized areas include the Houston Ship Channel, Buffalo Bayou, Brays Bayou, White Oak Bayou, Greens Bayou, Halls Bayou, Armand Bayou, lower Clear Creek, lower Dickinson Bayou, lower Cedar Bayou, Goose Creek, etc.

Who Lead entities: Local municipalities and POTW operators. Other participants: TNRCC and EPA. Role of Galveston Bay Program: Coordinating.

Public Costs of New Actions (5 years)

• Program ..... $ 37,500	• GLO ..... $ 15,000
• TNRCC..... $ 1,552,500	
TOTAL..... $ 1,605,000	

Private Costs: Probably low. Potential Sources of Funding: EPA and TWDB.

Regulatory Issues Initially the program will be voluntary. Rule making by the TNRCC under the Pollution Abatement for Municipalities rules might be required in two years if voluntary implementation is insufficient.

Related Actions: PS-1, PS-2, PH-2, and PH-3.

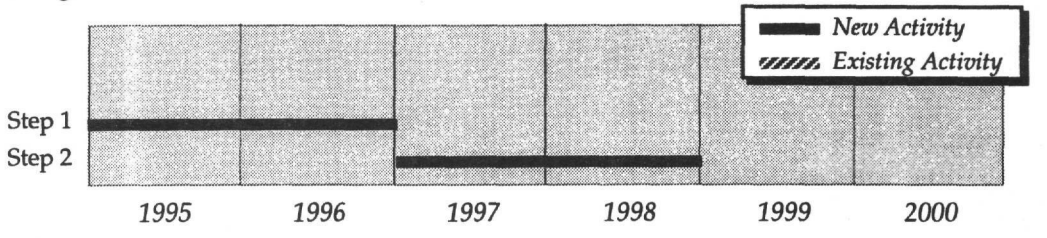
ACTION PS-6:
Issue NPDES Coastal General Permit or Eliminate Harm From Oil Field Produced Water Discharge

What Eliminate significant harm from produced water discharges by issuance of NPDES general permit or by implementation of a Texas Railroad Commission program.

How

Step 1 EPA may issue NPDES permit that will eliminate harm from produced water discharges.
Step 2 If EPA does not issue the permit, the RRC commission will take action to eliminate harm from produced water discharges.

When



Where All produced water discharges to bay waters and bay tributaries.

Who Lead entities: EPA and RRC. Other participants: Oil producers with produced water discharges. Role of Galveston Bay Program: Coordinating.

Public Costs of New Actions (5 years)

• Program	$ 59,000	• GLO	$ 22,500
• TNRCC	$ 37,500	• RRC	$ 33,750
TOTAL			$ 152,750

Note the RRC cost above is exclusive of costs of plugging abandoned wells or cleanup of abandoned sites. Private costs may be high as cost of new injection wells or the cost of plugging the ~600 producing wells can be significant. Potential Sources of Funding: NOAA, EPA and TWDB.

Regulatory Issues Need to issue NPDES permit or implement new RRC program.

Related Actions: WSQ-1, WSQ-2, WSQ-3, and WSQ-4.